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DEPARTMENT OF THE INTERIOR
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John S. Gottschalk, Director



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10162. Mraz, Donald. 1968. RECRUITMENT, GROWTH, EXPLOITATION AND MANAGEMENT OF WALLEYES IN A SOUTHEASTERN WISCONSIN LAKE. Wisconsin Dept. of Natural Resources Technical Bulletin No. 40. 38 p.

A population study of walleyes in 522-acre Pike Lake in southern Wisconsin was undertaken from 1959-62. Fyke nets were fished to obtain samples for growth and exploitation data while electrofishing gear was used to obtain fish for population estimates of young-of-the-year and yearlings. Petersen and Schnabel estimating methods suggested a reasonably stable recruitment of 5 to 10 young-of-the-year fish per acre in Pike Lake during the study period. Although estimates of both young-of-the-year and yearling walleyes showed a substantial mortality the second year, fluctuation in strength of the individual year classes and the variation in mortality tended to balance each other resulting in consistent recruitment of new fish to the population. The stocking of 4 to 5 thousand fingerling fish per year contributed little to the walleye population in Pike Lake. Presence of native fish was more than 50 times that of stocked fish in subsequent samples. Average length of samples of spawning run fish varied only 0.9 inch for males and only 0.7 inch for females over the four years, but the ranges of lengths within each age group were broad and considerably greater than the annual increments of growth. A high percentage of the male walleyes reached sexual maturity at age group III, while most females matured at age group IV. Only 4 percent of 1,994 mature males were less than 13 inches long, and only 6 percent of 840 females were mature below 16 inches in length. Male and female walleyes grew at much the same rate the first two years; annual increments for the females then exceeded those of the males by 0.5 to 0.9 inch for the next four years, and females were larger by 2.8 inches at the end of six years. Only 3 percent of 1,994 males were over 18 inches long while 20 percent of 840 females were over 20 inches and 2 percent over 25 inches long. No male aged was over 6 years, but females were aged to age group X. Fin clipping had no significant effect on growth, but tagging by placing aluminum strap tags on the upper jaw retarded annual growth by about 50 percent. Walleyes in Pike Lake were exploited by anglers at the consistent annual minimum rate of 20 percent, but probably actually closer to 25 percent, while annual natural mortality did not exceed 5-10 percent. (Auth.)

10163. Herman, Roger Lee (Bur. of Sport Fisheries and Wildlife, Eastern Fish Disease Lab., Kearneysville, W. Va.). 1968. FISH FURUNCULOSIS 1952-1966. Trans. Amer. Fish. Soc., 97(3): 221-230.

A review is made of the furunculosis literature based on a bibliography of papers published from 1952-1966. It is noted that furunculosis is still a serious problem. Rapid diagnostic procedures have been developed. New therapeutic drugs have been introduced for treatment of sulfa resistant strains of A. salmonicida. Genetic resistance to and oral immunization against furunculosis show promise but require further study. (Auth.)

10164. Schaefer, Milner B. (Office of the Science Adviser, Dept. of the Interior, Washington, D. C.). 1968. METHODS OF ESTIMATING EFFECTS OF FISHING ON FISH POPULATIONS. Trans. Amer. Fish. Soc., 97(3): 231-241.

The yield from an exploited fish population depends on the rate of harvesting (fishing mortality rate) and the magnitude of the standing stock. The latter is determined by rates of increase from recruitment and growth and rates of loss from both natural and fishing mortality. Since we lack information respecting the density-dependence of each of these rates, various simplifying assumptions are made in practice in developing mathematical models of exploited fish populations. Such models are described, with illustrations of their application to important commercial fisheries. Models of fisheries involving competing fish species, and the employment of computer simulation in studies of fishery-dynamics are also discussed. (Auth.)

10165. Patriarche, Mercer H. (Dept. of Conservation, Inst. for Fisheries Res., Museums Annex, Ann Arbor, Mich.). 1968. PRODUCTION AND THEORETICAL EQUILIBRIUM YIELDS FOR THE BLUEGILL (*Lepomis macrochirus*) IN TWO MICHIGAN LAKES. Trans. Amer. Fish. Soc., 97(3): 242-251.

Standing crop, production, exploitation, and theoretical maximum equilibrium yields were calculated for bluegill populations in Jewett Lake for 4 out of 6 years during the period 1957-1962, and in Lodge Lake for 1957-1958. The computation method for production and equilibrium yields utilized annual spring population estimates from trap-net data and seasonal instantaneous rates of mortality and growth. Fish less than 4.0 inches long (total length) were not included because of limitations of the sampling methods (angling and netting). During this time, spring standing crops of bluegills ranged between 5.2 and 65.0 lb. per acre in Jewett Lake; 21.3 lb. per acre for Lodge Lake. Production of new biomass by the populations ranged from 2.2 to 29.8 lb. per acre in Jewett Lake; 7.3 lb. per acre in Lodge Lake. Production by 4- and 5-year-old bluegills exceeded the weight taken by anglers in most instances, but among older fish yield outweighed production. Total production among these older age groups ranged from 44 to 48% of the standing crop in Jewett Lake, 34% for Lodge Lake. Fishing pressure varied from 70.5 to 115.0 hours per acre on Jewett Lake; 10.5-52.9 on Lodge Lake. There was no correlation between size of the spring populations and catch per hour. Exploitation rates, based on percentages of marked fish caught by anglers, ranged from 17.2-24.6% for Jewett Lake; 8.2-26.1% for Lodge Lake. These values were substantiated by rates computed on the basis of the proportion of available biomass (standing crop + production) harvested by fishermen. There was a significant tendency for anglers to catch or keep only the older individuals in 2 out of the 7 years. The calculations of maximum sustained yield revealed that, with one exception, these populations could have supported increases in fishing pressure ranging from 30 to 90% at the observed rates of fishing success. No appreciable change in growth rate would accompany this higher yield, an important condition for these calculations. The harvest from Jewett Lake in 1962 approximated the computed maximum equilibrium yield. It was suggested that the computational methods used in this paper will be useful in solving some of the problems associated with the management of prolific warmwater game fish by providing a rational basis for cropping overabundant populations. (Auth.)

10166. Siefert, Richard E. (North Central Reservoir Investigations, Bur. of Sport Fisheries and Wildlife, Yankton, S.D.). 1968. REPRODUCTIVE BEHAVIOR, INCUBATION AND MORTALITY OF EGGS, AND POSTLARVAL FOOD SELECTION IN THE WHITE CRAPPIE. Trans. Amer. Fish. Soc., 97(3): 252-259.

Observations of white crappie nests and spawning were made during 1965 and 1966 in pens built in a pond at the Gavins Point National Fish Hatchery, Yankton, South Dakota. Males exhibited territorial behavior, swept the spawning sites, and cared for eggs and prolarvae. A well defined nest depression was not constructed. No substrate preference for nesting was apparent, but fish appeared to select areas near objects or bottom vegetation. Polygamy and multiple spawnings by an individual fish occurred. Water depths over nests ranged from 20 to 97 cm; nests were in deeper water in 1965 than in 1966. Spawning occurred over a 20-day period in 1965 (May 14 to June 3) and a 29-day period in 1966 (May 17 to June 15). Water temperatures at spawning ranged from 14° to 23° C, with most spawning taking place at 16° to 20° C. Although April and May temperatures averaged 4.5° C lower in 1966 than in 1965, spawning in 1966 began only 3 days later than in 1965. Up to 50 spawning acts were observed during one spawning run and the longest lasted 145 minutes. Each act lasted from 2 to 5 seconds with most lasting 4. Intervals between spawning acts ranged from one-half to 20 minutes. The periods of egg incubation ranged from 42 to 103 hours and most rapid hatching occurred at warmer temperatures. Highest egg mortality with correspondingly longer incubation periods occurred in nests when water temperatures were lowest. The average time between start of hatching and departure of broods from the nests was 95 hours (range, 51 to 162 hours). Larvae absorbed the yolk sac when 4.5 to 4.6 mm long. Nauplii were the most important food item of larvae at the initiation of active

feeding. As fish attained a size of 6.0 to 7.9 mm, a sharp increase in selection of Cyclops occurred, and Daphnia became a significant food item of fish 10.0 to 13.9 mm long. Observations suggest that low temperatures before and during the spawning season may affect year-class strength. (Auth.)

10167. Ludke, J. Larry, Denzel E. Ferguson, and W. David Burke (Dept. of Zoology, Mississippi State Univ., State College, Miss.). 1968. SOME ENDRIN RELATIONSHIPS IN RESISTANT AND SUSCEPTIBLE POPULATIONS OF GOLDEN SHINERS, Notemigonus crysoleucas. Trans. Amer. Fish. Soc., 97(3): 260-263.

A 1,000 ppb endrin solution killed 50 susceptible golden shiners in 75 minutes but only 40 of 50 resistant shiners in 40 hours. Endrin residues in whole bodies of resistant shiners killed in endrin were as much as 82 times those of susceptible shiners. The endrin concentrations in the blood of living resistant shiners were as much as 64 times greater than those of endrin-killed susceptible shiners. We conclude that the use of a critical concentration in the blood for diagnosis of endrin-caused mortality must be based on the tolerances of local populations and may be invalid when applied to an entire species containing resistant populations. (Authors)

10168. Rose, Curt D., and W. W. Hassler (Dept. of Zoology, North Carolina State Univ., Raleigh, N. C.). 1968. AGE AND GROWTH OF THE DOLPHIN, Coryphaena hippurus (Linnaeus), IN NORTH CAROLINA WATERS. Trans. Amer. Fish. Soc., 97(3): 271-276.

The validity of age determinations from scales of dolphin (Coryphaena hippurus) captured off the North Carolina coast is established. Specimens were obtained from the local charter boat fishery. The greatest age of dolphin examined was 3 years. None of the 3-year-old fish and few of the 2-year-old fish were females. Predominance of males in age-groups II and III is believed to be caused by differential feeding habits of the sexes. Analysis of stomach contents indicates that older males may be more voracious feeders than older females; and, therefore, are most susceptible to capture by the hook-and-line fishery. Males are heavier than females throughout their complete length range. The body-scale relation is efficiently described by linear regression. Theoretical fish length at the time of scale formation was 93.75 mm. Growth in length of male and female dolphin was not significantly different. Rate of growth was independent of year of collection. Length at time of first annular formation was 653 mm. Annual increments were 271 mm during the second year, and 263 mm during the third year. (Authors)

10169. Fremling, Calvin R. (Winona State College, Winona, Minn.). 1968. DOCUMENTATION OF A MASS EMERGENCE OF Hexagenia MAYFLIES FROM THE UPPER MISSISSIPPI RIVER. Trans. Amer. Fish. Soc., 97(3): 278-281.

10170. Geen, G. H., and T. G. Northcote (Dept. of Biological Sciences, Simon Fraser Univ., Burnaby 2, B. C., Canada). 1968. LATEX INJECTION AS A METHOD OF MARKING LARGE CATOSTOMIDS FOR LONG TERM STUDY. Trans. Amer. Fish. Soc., 97(3): 281-282.

10171. Murray, A. R. (Fisheries Research Board of Canada Biological Station, St. John's, Newfoundland, Canada). 1968. ESTUARINE NET COUNTING FENCE FOR TRAPPING ATLANTIC SALMON. Trans. Amer. Fish. Soc., 97(3): 282-286.

10172. Summerfelt, Robert C., and William M. Lewis (Fish. Res. Lab., and Dept. of Zoology, Southern Illinois Univ., Carbondale, Ill.). 1968. A WATER SAMPLER EMPLOYING A SOLENOID TRIPPING MECHANISM. Trans. Amer. Fish. Soc., 97(3): 287-289.

10173. McLain, Alberton L., and Frederick H. Dahl (Bur. of Commercial Fisheries, Biological Station, Marquette, Mich.). 1968. AN ELECTRIC BEAM TRAWL FOR THE CAPTURE OF LARVAL LAMPREYS. Trans. Amer. Fish. Soc., 97(3): 289-293.

10174. Nelson, Joseph S. (Dept. of Zoology, Indiana Univ., Bloomington, Ind.). 1968. LIFE HISTORY OF THE BROOK SILVERSIDE, Labidesthes sicculus, IN CROOKED LAKE, INDIANA. Trans. Amer. Fish. Soc., 97(3): 293-296.

10175. Hale, John G. (Federal Water Pollution Control Administration, National Water Quality Lab., Duluth, Minn.). 1968. OBSERVATIONS ON BROOK TROUT, Salvelinus fontinalis SPAWNING IN 10-GALLON AQUARIA. Trans. Amer. Fish. Soc., 97(3): 299-300.

10176. Mullan, James W., Richard L. Applegate, and William C. Rainwater (Bur. of Sport Fisheries and Wildlife, Fayetteville, Ark.). 1968. FOOD OF LOGPERCH (Percina caprodes), AND BROOK SILVERSIDE (Labidesthes sicculus), IN A NEW AND OLD OZARK RESERVOIR. Trans. Amer. Fish. Soc., 97(3): 300-305.

10177. Simon, Raymond C., and Richard E. Noble (Oregon Cooperative Fishery Unit, Oregon State Univ., Corvallis, Oreg.). 1968. HYBRIDIZATION IN Oncorhynchus (SALMONIDAE). I. VIABILITY AND INHERITANCE IN ARTIFICIAL CROSSES OF CHUM AND PINK SALMON. Trans. Amer. Fish. Soc., 97(2): 109-118.

Survival and fertility are substantial in first-generation hybrids. Morphological features in the F₁ are either like one parent, unlike either parent, or intermediate. Failure of hybrids to be intermediate in some parental attributes is contrasted to earlier reports. Hybrid fertility is equated to persistence of parental traits in the phenotype of the F₁. Multiple and additive gene systems are assumed to be operative wherein dominance is suspected in two characteristics. Viability data are provided on F₁, F₂, reciprocal, and backcross hybrids. Morphological descriptions contained provide some basis for recognizing natural chum-pink hybrids. (Authors)

10178. Hettler, William F., Jr. (Bur. of Commercial Fisheries Biological Lab., Beaufort, N. C.). 1968. ARTIFICIAL FERTILIZATION AMONG YELLOWFIN AND GULF MENHADEN (Brevoortia) AND THEIR HYBRID. Trans. Amer. Fish. Soc., 97(2): 119-123.

Eggs of yellowfin menhaden, Brevoortia smithi, were artificially fertilized with sperm from yellowfin menhaden, Gulf menhaden (B. patronus), and naturally occurring hybrid menhaden, and reared through the larval yolk sac stage at sea under controlled temperature and salinity. Hatching occurred after 38 hours at 21° C. The last larva died 7 days after hatching. Specimens of embryos and larvae were preserved during development and later photographed. Survival of the cross-fertilized eggs equalled that of the intraspecific fertilizations. (Auth.)

10179. Bentley, Wallace W., and Howard L. Raymond (Bur. of Commercial Fisheries, 2725 Montlake Blvd., East, Seattle, Wash.). 1968. COLLECTION OF JUVENILE SALMONIDS FROM TURBINE INTAKE GATEWELLS OF MAJOR DAMS IN THE COLUMBIA RIVER SYSTEM. Trans. Amer. Fish. Soc., 97(2): 124-126.

Turbine intake gatewells at Ice Harbor Dam on the Snake River were evaluated for their utility as collection areas of juvenile salmonids. The investigation took place from 1964 through 1966; results indicated that gatewell collecting is economical and efficient. One 3-man crew, in 1964, did the sampling; depending on water flow, the collections represented 2 to 6% of the total population. The sampling rate in the gatewells will enable a high degree of confidence to be placed on measurements of timing, migration rates, survival, and relative magnitude of the seaward migrations. (Authors)

10180. Erdman, Donald S. (Dept. of Agriculture, Commonwealth of Puerto Rico, San Juan, P. R.). 1968. SPAWNING CYCLE, SEX RATIO, AND WEIGHTS OF BLUE MARLIN OFF PUERTO RICO AND THE VIRGIN ISLANDS. Trans. Amer. Fish. Soc., 97(2): 131-137.

Pronounced cyclic changes were discovered in the gonad sizes of 263 male and 65 female blue marlin, Makaira nigricans Lacépède. Fish with ripe testes were

found from May to November. A prespawning enlarged testis stage preceded the smaller ripe stage. Ripe testes became smaller in average size as the season progressed. The postspawning stage was notably smaller than the ripe stage. Critical stages were determined or confirmed by histological sections. Testis weight related to body weight, in percent, increased as much as 17 times from the postspawning to prespawning stage in adult males. Developed ovaries were observed from late May to September, and one female was ripe in September. The peak of the spawning period appeared to be July and August, when males and females were present in equal numbers. The largest male weighed 297 pounds; the largest female, 814 pounds. Females over 400 pounds were most frequent in the July catch, and second most frequent in August. There were 11 females in the modal weight group of 200 to 249 pounds. There were 163 males in the modal weight group of 100 to 149 pounds. Both modal weight groups were more frequent in the catches of September and October. (Auth.)

10181. Fry, James P., and Willis D. Hanson (Missouri Dept. of Conservation, Columbia, Mo.). 1968. LAKE TANEYCOMO: A COLD-WATER RESERVOIR IN MISSOURI. Trans. Amer. Fish. Soc., 97(2): 138-145.

Significant changes in the fishery of 1,730-acre Lake Taneycomo resulted from the construction of Table Rock Dam immediately upstream on White River because water, released through the dam from a relatively low level, is consequently quite cool. Discharge temperatures range from 40° to 60° F., and the cold water influences a large portion of Lake Taneycomo. Netting indicated an excellent population of warm-water fishes prior to the cold discharge from Table Rock Dam. Growth rates of warm-water species slowed markedly. Fishing pressure on the lower two-thirds of the reservoir was as high as 133 hours per acre annually before the change, with catch rates of over 1.0 fish per hour. White crappies made up half of the catch, by number, with bluegills and largemouth bass next. Low fishing pressure was observed on the upper one-third of the reservoir. About 1,600,000 rainbow trout were stocked to sustain the fishery, following the release of cold water from Table Rock Dam. Fishing pressure on the upper portion of Lake Taneycomo increased to 528 hours per acre with a catch rate of about 0.5 fish per hour. Relative numbers of rainbow trout in the creels increased steadily until they accounted for 99% in 1962 and 1963. Fishing pressure on the lower portion did not increase spectacularly; it was 87 hours per acre in 1963. Catch rate was 0.7 fish per hour, with rainbow trout comprising half the catch. Bluegill, white crappie, and largemouth bass were still taken in limited numbers. Tag returns revealed that the majority of the trout moved upstream, although some were captured as far as 95 miles downstream. Growth of trout tagged, when about 10 inches in length, averaged 0.4 inches per month. Those tagged at 6 inches averaged 0.6 inches per month. Tag returns were 22% of the larger size-group, but only 3% of the smaller size-group. (Authors)

10182. Dryer, William R., and Joseph Beil (Bur. of Commercial Fisheries, Ann Arbor, Mich.). 1968. GROWTH CHANGES OF THE BLOATER (*Coregonus hoyi*) OF THE APOSTLE ISLANDS REGION OF LAKE SUPERIOR. Trans. Amer. Fish. Soc., 97(2): 146-158.

Studies were based primarily on 3,097 bloaters collected in experimental gill nets and bottom trawls fished in 1958-65 in the Apostle Islands region of Lake Superior. The average size of bloaters increased considerably during the period. The percentage longer than 8.9 inches increased from 45% in 1959 to 99% in 1965. Calculated lengths were without exception higher in 1962-65 than in 1958-61. Growth in length and weight showed nearly steady improvement from 1951 to 1964. The species composition of chubs has apparently changed considerably over the past 40 years. The bloater has replaced the shortjaw cisco (*C. zenithicus*) as the principal species in commercial landings of chubs in Wisconsin. Annulus formation of bloaters extended from mid-May to August. Growth was slow during the spring and early summer but increased sharply in August. Age-group VI was dominant in the samples. Fluctuations in year-class strength were slight. Females outnumbered males in all age groups above III. The sex composition varied accord-

ing to season of capture. Some bloaters matured at age II and all fish older than III were mature. The shortest length of mature bloaters was 6.0 inches for males and 7.0 inches for females; all fish longer than 8.4 inches were mature. Apostle Island bloaters spawn principally in February and March. The average number of eggs produced by 20 females, 8.4 to 11.7 inches long, was 6,533. Crustaceans were the most common food. (Authors)

10183. Nelson, William R. (Bur. of Sport Fisheries and Wildlife, North Central Reservoir Investigations, Yankton, S.D.). 1968. REPRODUCTION AND EARLY LIFE HISTORY OF SAUGER, Stizostedion canadense, IN LEWIS AND CLARK LAKE. Trans. Amer. Fish. Soc., 97(2): 159-166.

Sauger (Stizostedion canadense) reproduction and early life history have been studied to determine factors affecting year-class strength in Lewis and Clark Lake, a 28,000-acre reservoir on the South Dakota-Nebraska border. Sauger spawn over a rubble substrate in the Missouri River below Fort Randall Dam. Spawning is initiated at a water temperature of 43° F and is complete in approximately 2 weeks. Maximum egg survival occurs 4 feet below minimum river water level. Eggs hatch in 21 days at an average temperature of 47° F and larvae drift down the Missouri River and into Lewis and Clark Lake. The yolk sac is absorbed in 7 to 9 days and larvae feed primarily upon Cyclops. Larger size larvae feed on Daphnia and Diaptomus. Fish are a major food after sauger reach 70 to 110 mm lengths. Adult year-class strength was inversely related to water level fluctuations over the spawning grounds. Abundance of larvae was 15 times greater in 1965 when water levels fluctuated 2.67 feet per day than in 1963 when water levels fluctuated 4.44 feet per day. Apparently, year-class strength is dependent upon water level fluctuation during the incubation period and is determined before young-of-the-year enter Lewis and Clark Lake. (Auth.)

10184. Nelson, William R. (Bur. of Sport Fisheries and Wildlife, North Central Reservoir Investigations, Yankton, S.D.). 1968. EMBRYO AND LARVAL CHARACTERISTICS OF SAUGER, WALLEYE, AND THEIR RECIPROCAL HYBRIDS. Trans. Amer. Fish. Soc., 97(2): 167-174.

Embryos and larvae of saugers, walleyes, and their reciprocal hybrids are described and compared. Sauger embryos and prolarvae, in contrast to walleye, are smaller and have less pigmentation. The yolk sac of a sauger is more oval than that of a walleye. Postlarval saugers and walleyes can be separated by characteristics of pigmentation, myomere counts, head length, and fin ray ossification. The number of pyloric caeca differentiates fish longer than 19 mm. Identification of larval hybrids is not possible since they closely resemble the female parent. Hybrids longer than 100 mm can be distinguished by their coloration pattern. (Auth.)

10185. Larimore, R. R. Weldon, and Michael J. Duever (Illinois Natural History Survey, Urbana, Ill.). 1968. EFFECTS OF TEMPERATURE ACCLIMATION ON THE SWIMMING ABILITY OF SMALLMOUTH BASS FRY. Trans. Amer. Fish. Soc., 97(2): 175-184.

Entire year classes of smallmouth bass are frequently lost in midwestern streams during floods that occur when the fry are less than 25 mm long. Since changes in air and water temperatures often accompany these floods, the effects of temperature on swimming ability of fry 20-25 mm in length were measured in the laboratory and related to floodwater conditions. Groups of fry were acclimated to temperatures of 5°, 10°, 15°, 20°, 25°, 30°, and 35° C and tested for swimming ability at each of these temperatures. The maximum swimming speed for fish acclimated to a particular temperature increased with successively higher test temperatures, to a level above which swimming ability declined rapidly. Swimming speeds attained were progressively higher for each higher level of acclimation with the exception of those from the upper extreme of 35° C. The best swimming performance was at a temperature above the acclimation temperature for all fry except those acclimated to 30° and 35° C and these fry failed to swim above their acclimation temperatures. Temperature changes in streams may not directly cause the displacement of smallmouth bass fry but may reduce their swimming ability and thereby contribute to their displacement when exposed to turbid and turbulent floodwaters. (Authors)

10186. Van Valin, Charles C., Austin K. Andrews, and Lafayette L. Eller (Bur. of Sport Fisheries and Wildlife, Fish-Pesticide Research Lab., Denver, Colo.). 1968. SOME EFFECTS OF MIREX ON TWO WARM-WATER FISHES. *Trans. Amer. Fish. Soc.*, 97(2): 185-196.

The effects of mirex on two species of warm-water fishes were studied in three experiments in which the fish were exposed either by feeding a mirex-treated diet, or by treating the holding ponds with a mirex formulation. Bluegills were used in the feeding experiment, where three different levels of mirex were incorporated into the diet and fed to fish held in plastic pools, and in the first pond-exposure experiment, in which the fish were held in earthen ponds treated once with a mirex-corn cob grit formulation. The third experiment used goldfish held in earthen ponds which also were treated once with the mirex-corn cob grit formulation. In general, higher rates of exposure produced higher whole-body residues of mirex in the fish, and, except in bluegills from the lower-treatment ponds of the first contact experiment and in control fish, whole-body residues increased throughout the terms of these experiments. Soil, water, and vegetation samples from the two contact experiments, although subject to large differences between individual samples, contained relatively unchanging mirex concentrations, illustrating that this chemical is highly resistant to degradation or removal. No mortality or tissue pathology in the bluegills could be ascribed to mirex exposure, but the gills and kidneys of mirex-exposed goldfish showed reactions beginning with the samples taken 56 days after treatment, and the numbers of these fish surviving until termination of this experiment were inversely related to treatment level. Total serum protein and hematocrit percentages had no apparent relationship to treatment levels, nor was mirex exposure a demonstrable factor in growth rates in the contact experiments. However, growth of the bluegills in the highest treatment groups of the feeding experiment was adversely affected. Invertebrate populations seemed not to be affected by the mirex treatment in either of the earthen pond experiments. (Authors)

10187. Hubbs, Clark (Univ. of Texas, Dept. of Zoology, Austin, Texas). 1968. AN OPINION ON THE EFFECTS OF CICHLID RELEASES IN NORTH AMERICA. *Trans. Amer. Fish. Soc.*, 97(2): 197-198.

The reputed benefits of cichlids seem similar to those listed for carp in the 1880's and 1890's.

10188. Bonham, Kelshaw (College of Fisheries, Univ. of Washington, Seattle, Wash.). 1968. GROWTH INHIBITION BY MAXILLARY EXCISION, SIZE AT START OF JAW ELONGATION, AND REGRESSION OF WEIGHT ON LENGTH OF PRECOCIOUS MALE CHINOOK SALMON. *Trans. Amer. Fish. Soc.*, 97(2): 198-201.

10189. Acara, A.H. (Fisheries Research Station, Fish and Wildlife Branch, Dept. of Recreation and Conservation, Nelson, B.C., Canada). 1968. A NORMAL, SYNCHRONOUS HERMAPHRODITE DOLLY VARDEN CHAR. *Trans. Amer. Fish. Soc.*, 97(2): 201-202.

10190. Armstrong, Robert H., and Peter C. Winslow (Div. of Sport Fish, Dept. of Fish and Game, Juneau, Alaska). 1968. AN INCIDENCE OF WALLEYE POLLOCK FEEDING ON SALMON YOUNG. *Trans. Amer. Fish. Soc.*, 97(2): 202-203.

10191. Gregory, Richard W. (Dept. Game, Fish, and Parks, Research Center, Ft. Collins, Colo.). 1968. OCCURRENCE OF FRUCTOSE IN TROUT SEMINAL PLASMA. *Trans. Amer. Fish. Soc.*, 97(2): 203-204.

10192. Perlmutter, Alfred, Man-Lim Yu, and Robert E. Servis. 1968. USE OF FISH EGGS FOR DIRECT ASSAY OF CHROMATOGRAPHICALLY SEPARATED COMPONENTS ON SILICA GEL PLATES. *Trans. Amer. Fish. Soc.*, 97(2): 204-207.

10193. Bridges, David W., and Michael P. Fahay (Sandy Hook Marine Laboratory, Bur. of Sport Fisheries and Wildlife, Highlands, N.J.). 1968. SEXUAL DICHROMATISM IN THE TAUTOG, *Tautoga onitis* (Linnaeus), WITH AN OBSERVATION OF POSSIBLE COURTSHIP BEHAVIOR. Trans. Amer. Fish. Soc., 97(2): 208-209.

10194. Johnson, James E. (Dept. of Zoology, Arizona State Univ., Tempe, Ariz.). 1968. ALBINISTIC CARP, *Cyprinus carpio*, FROM ROOSEVELT LAKE, ARIZONA. Trans. Amer. Fish. Soc., 97(2): 209-210.

10195. Scholl, Russell L. (Ohio Div. of Wildlife, Lake Erie Fisheries Unit, Ft. of Hancock St., Sandusky, Ohio). 1968. A RAPID DECALCIFYING METHOD FOR SECTIONING CHANNEL CATFISH PECTORAL SPINES. Trans. Amer. Fish. Soc., 97(2): 210-211.

10196. McCrimmon, Hugh R. (Dept. of Zoology, Univ. of Guelph, Guelph, Ontario, Canada). 1968. CARP IN CANADA. Fish. Res. Bd. Canada Bull. 165. 93 p.

The carp, *Cyprinus carpio* Linnaeus, as a result of introduction, is resident in the provinces of Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia. Natural barriers and dams deter further range expansion through natural movement into numerous potentially favorable aquatic habitats across Canada. Present annual commercial harvests, estimated at 2.5 million pounds, exploit only modestly available carp populations in Canadian waters. Live, dressed, and smoked fish constitute the traditional market with gefilte fish and caviar being more recent products. In spite of various recreational fisheries, the carp has not received general public acclaim as a sport fish in Canada, although angling, spearing, and bow-fishing are increasing in popularity. Public prejudice against the carp as a food and sport fish which continues to hamper utilization of the species, can be overcome only by increased effort in public education and product development. (Auth.)

10197. Fish, Frederic F. 1968. A CATALOG OF THE INLAND FISHING WATERS IN NORTH CAROLINA. North Carolina Wildlife Resources Comm., Raleigh, N.C. 312 p.

An effort at consolidating within the framework of a single reference, all available knowledge pertinent to fishing these waters. It was designed to guide the freshwater fisherman in pursuing the fish of his choice, to serve the interests of the many agencies concerned with various uses of North Carolina's fresh waters, and to assign to each body of fresh water in North Carolina a code number indicating the location and supplying identifying characteristics for that particular water adaptable to punch-card tabulation and analyses.

10198. Gunderson, Donald R. (Dept. of Zoology and Entomology, Montana State Univ., Bozeman, Mont.). 1968. FLOODPLAIN USE RELATED TO STREAM MORPHOLOGY AND FISH POPULATIONS. J. Wildlife Mgmt., 32(3): 507-514.

For two contiguous sections of a Montana stream, the agricultural use of the floodplain was related to cover, stream morphology, and fish populations. In one section the vegetation of the floodplain had been reduced by clearing and intensive livestock grazing; in the other section, which had received light use by livestock, vegetation was relatively unchanged. This ungrazed section had 76 percent more cover (undercut banks, debris, overhanging brush, and miscellaneous) per acre of stream than the grazed section. Brown trout (+ 6 inches) were estimated to be 27 percent more numerous and to weigh 44 percent more per acre in the ungrazed section of the stream, although their rate of growth was similar in the two stream sections. (Auth.)

10199. Thomas, Paul M., Romeo O. Legault, and George F. Carpenter (Calif. Inst. of Technology, Pasadena, Calif.). 1968. DURABILITY AND EFFICIENCY OF BRUSH SHELTERS INSTALLED IN 1937 IN DOUGLAS LAKE, MICHIGAN. J. Wildlife Mgmt., 32(3): 515-520.

Ten brush shelters were installed in Douglas Lake, Cheboygan County, Michigan, in 1937. Our studies of the shelters revealed in 1965, 1966, and 1967 that after

30 years the shelters had collapsed and spread out but were still concentrating game fish, much as they did when they were installed. The shelters also seemed to enhance the establishment of aquatic vegetation in and near them. (Authors)

10200. Beamish, F. W. H. (Fisheries Research Board of Canada Biological Station, St. Andrews, N. B., Canada). 1968. GLYCOGEN AND LACTIC ACID CONCENTRATIONS IN ATLANTIC COD (*Gadus morhua*) IN RELATION TO EXERCISE. J. Fish. Res. Bd. Canada, 25(5): 837-851.

In Atlantic cod, muscle glycogen was reduced by about 50% at moderate swimming speeds and over 80% at higher speeds. Muscle glycogen for a given swimming speed was generally lower after 30 minutes exercise than after 15 minutes exercise. During the 8-hour period after strenuous exercise, muscle glycogen increased but remained well below the level for unexercised fish. At moderate swimming speeds, fish exhibited comparatively small amounts of muscle and blood lactic acid. At higher swimming speeds, fish accumulated significantly larger quantities of lactic acid in the muscle and blood. During the recovery period after strenuous exercise, muscle and blood lactic acid increased perceptibly. Muscle lactic acid remained high for 1 hour after exercise and then decreased in 8 hours to levels similar to those of unexercised cod. Blood lactic acid followed a similar pattern except that it continued to increase for 1.5 hours after exercise. Serial samples of blood taken before and after 30 minutes strenuous exercise showed marked differences in lactic acid among individuals. Blood lactic acid usually continued to increase for 30-60 minutes after exercise, and decreased to the level for unexercised fish about 24 hours after exercise. No mortalities attributable to muscular fatigue occurred among cod. (Auth.)

10201. Edelhauser, Henry F., and Kenneth A. Siegesmund (Dept. of Physiology, Ophthalmology and Anatomy, Marquette School of Medicine, Milwaukee, Wisc.). 1968. ULTRASTRUCTURE OF TROUT CORNEA. J. Fish. Res. Bd. Canada, 25(5): 863-866.

The ultrastructure of the brook, brown, and rainbow trout cornea as observed using the light and electron microscopes is described. The transition between the central and limbal areas of the cornea is included. The limbal region, unlike the central cornea, contained epithelial microvilli, unorganized Bowman's membrane with various size collagen fibrils, and a stroma containing melanocytes and capillaries. These corneas also possess prominent keratocytes and an endothelium. (Authors)

10202. Scott, W. B., and S. N. Tibbo (Royal Ontario Museum, Toronto, Ont., Canada). 1968. FOOD AND FEEDING HABITS OF SWORDFISH, *Xiphias gladius*, IN THE WESTERN NORTH ATLANTIC. J. Fish. Res. Bd. Canada, 25(5): 903-919.

In the northern part of its western Atlantic range, the swordfish feeds on relatively few species of fish. Volumetrically the most important species are Atlantic mackerel, barracudinas, silver hake, redfish, and Atlantic herring. Squid are also important in the diet, and accounted for nearly one-fifth of the volume in the stomachs examined. There is evidence that the swordfish frequently uses its sword to attack and disable even small individual food items before ingesting them. (Authors)

10203. Bilton, H. T., and D. W. Jenkinson (Fisheries Research Board of Canada Biological Station, Nanaimo, B. C., Canada). 1968. COMPARISON OF THE OTOLITH AND SCALE METHODS FOR AGING SOCKEYE (*Oncorhynchus nerka*) AND CHUM (*O. keta*) SALMON. J. Fish. Res. Bd. Canada, 25(5): 1067-1069.

10204. Manzer, J. I. (Fisheries Research Board of Canada Biological Station, Nanaimo, B. C., Canada). 1968. FOOD OF PACIFIC SALMON AND STEELHEAD TROUT IN THE NORTHEAST PACIFIC OCEAN. J. Fish. Res. Bd. Canada, 25(5): 1085-1089.

10205. Stewart, Kenneth W., and Catherine B. Levin (Dept. of Zoology, Univ. of Manitoba, Winnipeg, Man., Canada). 1968. A METHOD OF OBTAINING PERMANENT DRY MOUNTED CHROMOSOME PREPARATIONS FROM TELEOST FISH. J. Fish. Res. Bd. Canada, 25(5): 1091-1093.

10206. Harvey, H.H., W.S. Hoar, and C.R. Bothern (Dept. of Zoology, Univ. of Toronto, Toronto, Ont., Canada). 1968. SOUNDING RESPONSE OF THE KOKANEE AND SOCKEYE SALMON. J. Fish. Res. Bd. Canada, 25(6): 1115-1131.

When frightened, sockeye and kokanee salmon dive into deeper waters. This is termed the "sounding response". The sounding response in these fish is accompanied by the expulsion of gas from the swimbladder via the pneumatic duct. This gas loss is active and results from the contraction of the circular muscle fibers in the wall of the swimbladder. Gas loss on sounding is reduced or obviated after exposure to adrenergic blocking agents and enhanced in fish treated with sympathomimetics. Circular muscle fibers in intact and isolated strips of swimbladder contracted in response to sympathomimetics, but this response was prevented after adrenergic blockade. These results suggest the concentration of the swimbladder and associated gas expulsion is under adrenergic control. In untreated fish, an average pressure of 28.1 mm Hg was required to force gas out of the swimbladder through the pneumatic duct. In antroprine-treated fish this duct-release pressure fell to an average of 0.2 mm Hg. This suggests constriction of the pneumatic duct is under cholinergic control. Histologically, the pneumatic duct was continuous with the oesophagus and extended as a convoluted duct to the anterior end of the swimbladder. Smooth muscle fibers surrounded the duct along its length and some striated fibers were present at the point where the duct joined the oesophagus. Occlusion of the pneumatic duct may be through the contraction of either of these types of fibers. The term "Gasspuckreflex" as originally used by Franz described the loss of gas from the swimbladder of physostomes in response to decompression. The authors suggest this term be reserved for this passive loss of gas, and not applied to fright-induced gas loss, resulting from active contraction of the bladder wall. (Authors)

10207. Keast, Allen, and Linda Welsh (Dept. of Biology, Queen's Univ., Kingston, Ont., Canada). 1968. DAILY FEEDING PERIODICITIES, FOOD UPTAKE RATES, AND DIETARY CHANGES WITH HOUR OF DAY IN SOME LAKE FISHES. J. Fish. Res. Bd. Canada, 25(6): 1133-1144.

The feeding periodicities of five common cohabiting fish species in Lake Opinicon, Ontario, were defined for the early summer period of accelerated feeding by determining the mean weights of stomach contents per gram of body weight at intervals of 2-3 hours throughout the 24-hour cycle. Two, and in sunfish three, feeding peaks per 24-hour period were indicated. *Perca flavescens* was diurnal; *Lepomis macrochirus*, *L. gibbosus*, and *Fundulus diaphanus* were largely diurnal (with a nocturnal component); and *Ambloplites rupestris* was equally nocturnal and diurnal. In the two sunfish there were clearcut differences in the organisms eaten by day and night. The technique developed here is a useful method for determining the mean minimum daily ration for a population of fish in the field. The results are comparable with those obtained by other workers in aquarium feeding experiments. (Authors)

10208. Spangler, George R. (Dept. of Zoology, Univ. of Toronto, Toronto, Ont., Canada). 1968. ANGLER HARVEST AND MORTALITY OF *Esox masquinongy* IN PIGEON AND STURGEON LAKES, ONTARIO. J. Fish. Res. Bd. Canada, 25(6): 1145-1154.

In 1961 a creel census was begun on Pigeon Lake in south-central Ontario to assess the contribution to the fishery of maskinonge transplanted from nearby Nogies Creek Fish Sanctuary. A correction being made for a tag loss of 58%, it was estimated that 30% of the transplanted fish had appeared in the anglers' catch. The mean catch of maskinonge from Pigeon Lake for the seasons of 1961-65 was estimated to be 1,318 fish per year. About 4% of the annual catch from Pigeon Lake was attributed directly to fish transplanted from Nogies Creek. From a

catch curve the rate of total mortality of Pigeon Lake maskinonge age V or older was estimated to be 43% per year. Partitioning this into mortality due to fishing and mortality from other causes yielded estimates of 24.5% for each of these components. (Auth.)

10209. Buerkle, Udo (Fisheries Research Board of Canada Biological Station, St. Andrews, N.B., Canada). 1968. RELATION OF PURE TONE THRESHOLDS TO BACKGROUND NOISE LEVEL IN THE ATLANTIC COD (*Gadus morhua*). J. Fish. Res. Bd. Canada, 25(6): 1155-1160.

A conditioning procedure was used to determine auditory thresholds of cod at frequencies 35.3, 70.7, 141, 283, and 400 Hz at four levels of background noise. The noise was produced in octave bands centered at the test frequencies, and ranged in level from -14 db to +4 db (re 1 microbar). Up to 283 Hz thresholds varied directly with background noise, and signal-to-noise levels at thresholds remained approximately the same at all background noise levels for each frequency. Thresholds at 400 Hz were much higher and showed no relationship to noise. Mean signal-to-noise levels are calculated. (Auth.)

10210. Graham, Joseph J., and Paul M.W. Venno (Bur. of Commercial Fisheries, Biological Lab., West Boothbay Harbor, Me.). 1968. SAMPLING LARVAL HERRING FROM TIDEWATERS WITH BUOYED AND ANCHORED NETS. J. Fish. Res. Bd. Canada, 25(6): 1169-1179.

Buoyed and anchored nets were evaluated as a method of sampling larval Atlantic herring, *Clupea harengus harengus* Linnaeus, in tidewaters. The method permitted exploratory sampling in areas difficult to reach with towed gear, and provided a large number of samples from pre-determined depths without towing from vessels. The nightly variation of catch rates was small under similar tidal conditions, and seasonal changes in larval catches were similar to those determined by towing nets from a boat. The buoyed net also provided information relating the distribution of larvae to tidal currents that could not be readily obtained with towed gear. (Authors)

10211. Powers, Charles F., and Andrew Robertson (Great Lakes Research Div., Univ. of Michigan, Ann Arbor, Mich.). 1968. SUBDIVISIONS OF THE BENTHIC ENVIRONMENT OF THE UPPER GREAT LAKES, WITH EMPHASIS ON LAKE MICHIGAN. J. Fish. Res. Bd. Canada, 25(6): 1181-1197.

An effort has been made to introduce a greater degree of standardization and reliability into descriptions of the benthic environment made by biologically oriented observers. Comparisons of field descriptions and mechanical analyses showed an encouraging ability to distinguish among four major sediment types in Lake Michigan. The bottom of the lake has been described in terms of these types, which usually occur in the following order with respect to depth: sand, silty sand-sandy silt, silt-clayey silt in a thin layer overlying stiff plastic clay, and silt-clayey silt only. Each sediment type tends to exhibit its own range of organic carbon values, with the amount of carbon increasing with depth. Hard or rocky bottom occurs in more restricted areas and is considered a fifth recognizable bottom category. Certain features of the distribution of the sediments may be related to gross water movements and to the locations of the mouths of large tributary rivers. Limited comparative studies in Lakes Huron and Superior showed similar distributions of sediment types and organic carbon content. It is suggested that the observed uniformity of maximum organic carbon values in the sediments of all three lakes may be related to processes of oxidation. (Authors)

10212. Keast, Allen (Dept. of Biology, Queen's Univ., Kingston, Ont., Canada). 1968. FEEDING OF SOME GREAT LAKES FISHES AT LOW TEMPERATURES. J. Fish. Res. Bd. Canada, 25(6): 1199-1218.

Field studies on low temperature feeding in freshwater fishes were carried out as follows: (1) Fish Lake, near Picton, Ontario, January-March 1966 and 1967, 1,200 fish netted from under the ice at a temperature of 4° C; (2) Little Cataraqui Creek near Collins Bay, April 1966, groups of fish (total, 544 individuals) netted

at intervals of several days as the water temperature rose from 6.8° to 11° C; (3) Upper Jones Creek, near Mallorytown, two extensive collections (total, 1,005 individuals) made between April 27 and 30, 1966 (at a water temperature of 8° C), and May 15 and 17 (15° C). The following findings resulted. Some members of all six species in Fish Lake contained food but the percentage varied from 50% in Umbra limi down to 10% in Fundulus diaphanus. Hence feeding was erratic. Within species the smaller individuals invariably contained more food (0.005-0.02 g of alimentary contents per gram body weight) than larger fish (0.002-0.005). The same was true of smaller, as compared with larger, bodied species, with the exception of F. diaphanus. After the thaw in Little Cataragui Creek active feeding commenced at different temperatures in the various species: it was already under way at 6.5° C (when the study started) in Ictalurus nebulosus and Pomoxis nigromaculatus, but did not start in Lepomis gibbosus and Ambloplites rupestris until the water temperature reached 8.5° C. Prior to this the stomachs of species were shrunken, mucous-filled, and drawn far forward in the body cavity. Few Perca flavescens, active winter feeders, fed in April, immediately prior to spawning. In most of the Jones Creek fishes there was a marked increase in weight of alimentary contents (gram per gram body weight) between 8° and 15° C. Exceptions were the larger Semotilus atromaculatus, which were then spawning, and U. limi and Eucalia inconstans, which were sampled before their peak daily feeding times. To the differences in weights of alimentary contents at 8° and 15° C must be added accelerated digestion rates at 15° C. In all the waterways studied the fish consumed a much smaller range of prey items at low temperatures than at higher ones. This applied in midwinter, compared with summer, in Fish Lake, and in April and October, compared with summer, in Jones Creek. A few foods, e.g. chironomid larvae and Cladocera, were especially prominent in the diet at low temperatures, and species food specializations were suppressed. There was probably not, however, any increase in interspecific competition at temperatures approaching zero, because of the relatively low metabolic requirements of the fish. (Auth.)

10213. Mathews, Stephen B. (Fisheries Research Inst., Univ. of Washington, Seattle, Wash.). 1968. AN ESTIMATE OF OCEAN MORTALITY OF BRISTOL BAY SOCKEYE SALMON THREE YEARS AT SEA. J. Fish. Res. Bd. Canada, 25(6): 1219-1227.

The method of population estimation based on change in composition of a dichotomous population was applied to Bristol Bay sockeye salmon to estimate the mortality rate of 3-ocean (3 years at sea) fish during their final year in the ocean. A difference in freshwater age composition between 1-ocean immatures in 1964 and 2-ocean immatures in 1965 was evident in samples taken in the high seas. This difference was apparently due to a greater tendency of 2-freshwater fish than 1-freshwater fish to mature after 2 years at sea. The known quantities of these two freshwater categories in the mature 2-ocean run of 1965 enabled an estimate of the population of 2-ocean immatures at sea in 1965. From this estimate and the quantity of 3-ocean matures in the 1966 run, the annual mortality rate was estimated to be .42. (Auth.)

10214. Duthie, Hamish C. (Dept. of Biology, Univ. of Waterloo, Waterloo, Ont., Canada). 1968. ECOLOGY OF PHYTOPLANKTON IN LAKE BELWOOD, A STORAGE RESERVOIR IN SOUTHERN ONTARIO. J. Fish. Res. Bd. Canada, 25(6): 1229-1245.

A 16-month study on a storage reservoir explained some of the factors controlling the seasonal development of phytoplankton in such an environment. Thermal stratification was unstable but was established in one of the two summers of the study and was associated with oxygen depletion in the hypolimnion. Both nitrate and phosphate concentrations showed distinct seasonality and the amounts in the influent were very similar to the amounts in the effluent. Large populations of Cryptomonas spp. developed in the early summer, when amounts of phosphate and nitrate were minimal, and were followed by a succession of planktonic Cyanophyta lasting into the winter. A population of Peridinium aciculiferum (Lemm.) Lemm. occurred over the winter. Based on their ecology in the reservoir the

species of phytoplankton were divided into three groups: an autochthonous group, which developed populations simultaneously all over the lake; an allochthonous group, which sometimes formed populations around the inflow; and the river plankton, which rarely developed in the reservoir. (Auth.)

10215. Bell, Gordon R. (Fisheries Research Board of Canada Biological Station, Nanaimo, B. C., Canada). 1968. DISTRIBUTION OF TRANSAMINASES (AMINO-TRANSFERASES) IN THE TISSUES OF PACIFIC SALMON (*Oncorhynchus*), WITH EMPHASIS ON THE PROPERTIES AND DIAGNOSTIC USE OF GLUTAMIC-OXALACETIC TRANSAMINASE. J. Fish. Res. Bd. Canada, 25(6): 1247-1268.

A partially purified glutamic-oxalacetic transaminase (GOT) from salmon liver was shown likely to function best at $\text{pH} > 7.5$, to be specific for the L isomer of aspartic acid, and to require pyridoxal phosphate for activity. The coenzyme appeared to be tightly bound to the apoenzyme. A survey of the scope of apparent transaminations in dialyzed homogenates of brain, heart, kidney, liver, and muscle indicated that GOT and glutamic-pyruvic transaminase were active in all tissues and that α -ketoglutarate (α -KG) was a more widely used amino acceptor than pyruvate. No transamination to the amino acceptors α -KG or pyruvate could be detected using as donors β -alanine, D-alanine, γ -aminobutyrate, glycine, histidine, proline, serine, or threonine. The following amino acids showed various degrees of transamination with α -KG in at least some tissue homogenates: L-leucine, L-norvaline, L-ornithine, L-phenylalanine, L-tyrosine, and L-valine. Interpretation of these results is discussed, particularly in relation to comparative biochemistry. Spectrophotometric estimations of plasma or serum GOT levels were used to distinguish at a significant level ($p < 0.01$), apparently healthy fish from those treated with the hepatic poisons bromobenzene and CCl_4 or those affected by bacterial kidney disease. The practical value of using GOT estimations as a diagnostic tool is discussed. It is tentatively suggested from limited data that the activity (units of enzyme/milligram tissue N) of GOT in various tissues decreases in the following order: heart, liver, kidney, and muscle. (Auth.)

10216. Bursa, Adam S. (Fisheries Research Board of Canada, Arctic Biological Station, Ste. Anne de Bellevue, Que., Canada). 1968. STARCH IN THE OCEANS. J. Fish. Res. Bd. Canada, 25(6): 1269-1284.

Starch observed in arctic waters of Canada, in the Baltic and Mediterranean seas, in the North Atlantic and Indian oceans, and in the waters about Bermuda, the Virgin Islands, and Jamaica is formed mostly in Gymnodinioidae, benthic algae, and higher aquatic plants and rarely in planktonic Chlorophyceae. In these phytoflagellates the fragile pellicle breaks when there are critical changes in salinity, temperature, or pressure and is subsequently decomposed by bacteria. The starch retains its shape after destruction of the protoplast, and accumulates in large quantities in aquatic habitats. Standing crops of free starch grains mark past blooms and mass mortalities of phytoplankton. The largest potato-like starch grains found in the oceans appear to be derived from the ocellar lenses of Warnowiaceae. Though Protozoa and various herbivores may ingest free planktonic starch, they were not observed to digest it. Large standing crops of starch and monosaccharides derived from amylolysis may affect nutrition in some animals, and influence the optical and chemical properties of sea water. Amylogenesis in some dinoflagellates starts from chondriosomes which are specialized in this process. In Prorocentrideae starch is formed within the ectoplasmic reticulum. (Auth.)

10217. Chaston, I. (Dept. of Zoology, Univ. of Exeter, England). 1968. INFLUENCE OF LIGHT ON ACTIVITY OF BROWN TROUT (*Salmo trutta*). J. Fish. Res. Bd. Canada, 25(6): 1285-1289.

10218. Kutty, M. Krishnan (Biological Oceanography Div., National Inst. of Oceanography, Ernakulam-1, India). 1968. ESTIMATION OF THE AGE OF EXPLOITATION AT A GIVEN FISHING MORTALITY. J. Fish. Res. Bd. Canada, 25(6): 1291-1294.

10219. Hoyle, R. J., and D. R. Idler (Fisheries Research Board of Canada, Halifax Laboratory, Halifax, N. S., Canada). 1968. PRELIMINARY RESULTS IN THE FERTILIZATION OF EGGS WITH FROZEN SPERM OF ATLANTIC SALMON (*Salmo salar*). J. Fish. Res. Bd. Canada, 25(6): 1295-1297.

10220. Topp, Robert W. (Massachusetts Cooperative Fishery Unit, Univ. of Massachusetts, Amherst, Mass.). 1968. AN ESTIMATE OF FECUNDITY OF THE WINTER FLOUNDER, *Pseudopleuronectes americanus*. J. Fish. Res. Bd. Canada, 25(6): 1299-1302.

10221. Burrows, Roger E., and Bobby D. Combs (Bur. of Sport Fisheries and Wildlife, Salmon-Cultural Lab., Longview, Wash.). 1968. CONTROLLED ENVIRONMENTS FOR SALMON PROPAGATION. Progr. Fish-Cult., 30(3): 123-136.

Environmental control of fish-rearing facilities has been made possible by developing a method of reconditioning water for reuse. Oxygen is replenished and carbon dioxide removed by aspiration and violent agitation of the recirculated water. Ammonia is converted to nitrates by nitrification with filtration through oyster shell and sharp rock. The amount of supplemental water necessary for operation ranges from 2 to 10% dependent on the environment to be created. Temperature control is effected by the addition of satisfactory supplemental water or the heating or cooling of the recirculated water. Unless disease-free spring or ground water is available, the supplemental water is sterilized by means of filtration and ultraviolet radiation. The facilities, equipment, and routines necessary for operation of large and small hatchery systems are described, and design drawings of a large system are presented. (Authors)

10222. Patrick, Ruth, John Cairns, Jr., and Arthur Scheier (Limnology Dept., Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.). 1968. THE RELATIVE SENSITIVITY OF DIATOMS, SNAILS, AND FISH TO TWENTY COMMON CONSTITUENTS OF INDUSTRIAL WASTES. Progr. Fish-Cult., 30(3): 137-140.

A diatom (*Nitzschia linearis* W. Sm.), a snail (*Physa heterostropha* Say), and the bluegill (*Lepomis macrochirus* Raf.) were exposed separately under controlled environmental conditions to various compounds found in industrial wastes. Eighteen series of bioassays made with diatoms and fish showed that the diatoms were more sensitive than fish in 10 and the fish more sensitive than the diatoms in 7, with 1 nearly identical response (acetic acid). Eight compounds tested for all 3 organisms showed that the fish were most sensitive in 3 instances, the diatoms in 3, and the snails in 2. These results indicate that the relative sensitivity is not constant. For example, for potassium chloride, the TL_{50} of the snail was 940 ppm, the diatom 1,337 ppm, and the fish 2,010 ppm. For phenol, the TL_{50} of the fish was 13.5 ppm, the snail, 94.0 ppm and the diatom 253 ppm. With potassium dichromate, the TL_{50} of the diatom was 0.203 ppm Cr, the snail 17.3 ppm, and the fish 113 ppm. Standards designed only to protect fish may result in concentrations which are lethal to other aquatic species, but we have no assurance that concentrations which are nonlethal to microorganisms and invertebrates will also be nonlethal to fish. To maintain balanced functional aquatic communities, we would be well advised to do bioassays with at least 3 components of the food web. (Authors)

10223. Fraser, J. M. (Ontario Dept. of Lands and Forests, Maple, Ont., Canada). 1968. EFFECT OF AIR PLANTING ON DOMESTIC BROOK TROUT. Progr. Fish-Cult., 30(3): 141-143.

Domestic brook trout (*Salvelinus fontinalis*) yearlings dropped in a free fall from heights of 200 and 400 feet into a hatchery pond experienced negligible mortality at the time of the drop or within 18 days after the drop. (Auth.)

10224. Neate, Harry (Fisheries Research Board of Canada Biological Station, Nanaimo, B. C., Canada). 1968. GEAR MODIFICATIONS FOR THE ELECTRO-FISHING OF UNDERYEARLING COHO SALMON. Progr. Fish-Cult., 181-182.

Hand-carried equipment is most practical in rough country with dense underbrush. Wire mesh vegetable strainers made the best electrode-scoops, and small motorcycle batteries provided a light power source. (Auth.)

10225. Snow, J.R. (Bur. of Sport Fisheries and Wildlife, Marion, Ala.). 1968. PRODUCTION OF SIX- TO EIGHT-INCH LARGEMOUTH BASS FOR SPECIAL PURPOSES. *Progr. Fish-Cult.*, 30(3): 144-152.

Largemouth bass (*Micropterus salmoides*) 6 to 8 inches in total length were produced on a ration of ground frozen fish or a mixture of fish and other components in 80 to 100 days after an initial training period in small concrete holding tanks. Growth prior to training was on natural food in an earthen rearing pond. Food and labor cost about \$1.03 per pound over a 2-year period for a small-scale operation. The fed fish spawned successfully at 1 year of age. Also, they readily adjusted to a diet of live forage fish and made excellent growth during fall and winter. (Auth.)

10226. Graff, Delano R. (Pennsylvania Fish Comm., Benner Spring Fish Research Station, Bellefonte, Pa.). 1968. THE SUCCESSFUL FEEDING OF A DRY DIET TO ESOCIDS. *Progr. Fish-Cult.*, 30(3): 152.

Tests of the acceptability of hatchery diets to northern pike (*Esox lucius*), chain pickerel (*E. niger*), muskellunge (*E. masquinongy*), and a hybrid (northern pike and muskellunge) showed greatest success with the northern pike and the hybrid. Northern pike that had never received live food accepted trout starter and then trout crumble; northern pike that had fed on daphnia and sucker fry converted to trout food. The hybrid readily accepted the dry diet. Mixtures of ground fish and daphnia, or of ground beef liver and daphnia, gave survival as good as that in units fed only daphnia. Units fed only ground fish or only ground liver had very high mortalities.

10227. Martin, Richard Lee (Dept. of Zoology, Ohio State Univ., Columbus, Ohio). 1968. COMPARISON OF EFFECTS OF CONCENTRATIONS OF MALACHITE GREEN AND ACRIFLAVINE ON FUNGI ASSOCIATED WITH DISEASED FISH. *Progr. Fish-Cult.*, 30(3): 153-158.

Malachite green and acriflavine were tested at different concentrations and times on 8 species of parasitic fungi. Malachite green at 1 ppm for 5 minutes prevented infestation of new sesame seeds by *Saprolegnia parasitica*, though it was so tolerant of acriflavine as to require 100 ppm for 12 hours to stop propagation. *S. ferax* showed similar results, but was still capable of propagation when treated with 1 ppm of malachite green for 5 minutes, and 5 ppm for 5 minutes inhibited further growth; acriflavine did not affect this species even at 100 ppm for 24 hours. *Achlya flagellata* was incapable of propagation onto new seeds after treatment with malachite green at 15 ppm for 5 minutes. *A. oblongata* (previously not listed as a fish parasite) was capable of propagation until treated with malachite green at 15 ppm for 1 hour. Neither *A. flagellata* nor *A. oblongata* was tested with acriflavine. *A. racemosa* became incapable of propagation onto new seeds after treatment with malachite green at 5 ppm for 5 minutes; acriflavine at 100 ppm for 24 hours failed to stop propagation. Malachite green at 10 ppm for 5 minutes made *A. ambisexualis* (both mating-type strains) incapable of propagating onto new seeds; acriflavine had the same effect. *Allomyces macrogynus* required acriflavine at 75 ppm for 5 minutes to stop infestation of seeds. The selectivity of acriflavine, and perhaps of other aniline dyes, may make possible less frequent use of malachite green. (Auth.)

10228. Carter, Neil Enoch (Oklahoma State Univ., Stillwater, Okla.). 1968. FLOAT UNIT DESIGN FOR SUSPENDING VERTICAL GILL NETS. *Progr. Fish-Cult.*, 30(3): 158.

Two 3- by 3-foot frames were held in position by 2 nylon braided ropes; a 20-foot floatable net roller was tied to the frames in the set position and locked into the upper part of the frame stands in the raise-lower position. The float unit was resistant to wave damage; required only 1 person for assembly, fish removal, and disassembly; was moved from station to station in a 16-foot flatbottom boat; and could have its net roller raised several feet above water during fish removal. (Auth.)

10229. Kelley, John W. (Dept. of Conservation, Cornell Univ., Ithaca, N. Y.). 1968. EFFECTS OF INCUBATION TEMPERATURE ON SURVIVAL OF LARGE-MOUTH BASS EGGS. *Progr. Fish-Cult.*, 30(3): 159-163.

Naturally spawned eggs of *Micropterus salmoides* were incubated in the laboratory at 8 temperature levels from 50° to 85° F. Egg samples were divided into 2 groups, one of which was acclimated at 0.5° F per hour to the desired incubation level. The second group was subjected to temperature shock of direct transfer. Hatching success was high for both groups (84 to 100%) in the 55° to 75° F range; it was generally significantly higher at the 50°, 80°, and 85° F levels for acclimated eggs. Preliminary work suggests that other factors such as dissolved oxygen and siltation may be more directly related to egg mortality in the 55° to 75° range than water temperature fluctuation per se. (Auth.)

10230. Hunn, Joseph B., Richard A. Schoettger, and Everett W. Whealdon (Bur. of Sport Fisheries and Wildlife, Fish Control Lab., La Crosse, Wisc.). 1968. OBSERVATIONS ON THE HANDLING AND MAINTENANCE OF BIOASSAY FISH. *Progr. Fish-Cult.*, 30(3): 164-167.

Observations on handling, holding, feeding, and maintaining fresh-water fish for bioassay are given. Diets for maintaining 17 species of fish are presented with feeding regime. Hematological parameters (Hb, Hct, and total plasma protein) are given for 16 species maintained under the conditions. An essential part of the routine is the establishment of criteria determining whether fish are to be put into the testing program or be discarded. (Authors)

10231. Amend, Donald F., and John L. Fryer (Fish Comm. of Oregon, Clackamas, Oreg.). 1968. THE ADMINISTRATION OF SULFONAMIDE DRUGS TO ADULT SALMON. *Progr. Fish-Cult.*, 30(3): 164-167.

Sulfadimethoxine (Bactrovet), sulfisoxazole (Gantrisin), sulfamethazine (Sulmet), and sulfaethoxyypyridiazine (S. E. Z.) were injected intraperitoneally (IP) or intramuscularly (IM) into adult chinook salmon (*Oncorhynchus tshawytscha*) to determine the absorption, elimination, and toxicity of these compounds to adult salmon. Concentrations of 20 mg of drug per 100 ml of blood occurred after an IP dose of 100 mg per pound of fish and did not cause mortality. Dosages above this level resulted in blood levels over 20 mg per 100 ml blood and fish mortality. Bactrovet persisted in the blood the longest, and Gantrisin the least. The rate of absorption and elimination of Bactrovet was similar when administered IM. Bactrovet was administered IP and IM to maturing coho salmon (*O. kisutch*) to determine whether treated fish remained fertile and their progeny developed normally. All fish spawned normally, but there was an increase in loss of eggs and fry from fish injected IP with saline with or without the drug. The loss was associated with an increased incidence of "white spot." Fish receiving Bactrovet IM developed sterile hemorrhagic abscesses at the site of inoculation, but there was no increase in loss of eggs or fry attributable to the IM inoculations. (Authors)

10232. Willoughby, Harvey (Bur. of Sport Fisheries and Wildlife, Washington, D. C.). 1968. A METHOD FOR CALCULATING CARRYING CAPACITIES OF HATCHERY TROUGHS AND PONDS. *Progr. Fish-Cult.*, 30(3): 173-174.

A formula for calculating the carrying capacities of hatchery troughs and ponds was developed, based on the available oxygen in the water supply. The quantity of available oxygen (that portion above 5 ppm) at any given rate of flow for a 24-hour period determines the amount of food which can be metabolized per day by the fish in the water. Once this is known, hatchery feeding tables can be used to determine the maximum number or weight of fish that can be carried safely at any given temperature. (Auth.)

10233. Lockard, Dale V. (Nevada Fish and Game Comm., Ely, Nev.). 1968. AN OPERCULAR STREAMER TAG. *Progr. Fish-Cult.*, 30(3): 175-177.

An opercular streamer tag using a nylon-reinforced plastic has proved suitable on the centrarchids and larger salmonids (8 inches or more). Its use in conjunction with a monel staple has shown retention up to 64% in 3-1/2 years for rainbow trout

(*Salmo gairdneri*) in raceway conditions. On wild bass returns, 100% of the tags were in excellent condition and well attached. To date, tags have been numbered by hand with a vinyl ink. The tag is attached to the bony operculum, and no festering or inflammation has been observed. (Auth.)

10234. Gasaway, Charles R., and Victor W. Lambou (Oklahoma Fishery Research Lab., Norman, Okla.). 1968. A SIMPLE SURFACE-MIDWATER TRAWL. Progr. Fish-Cult., 30(3): 178-180.

A simple, inexpensive surface-midwater trawl was designed for collecting fish in the limnetic region. The trawl requires no depressors, hydrofoils, or otter boards. It is held open at the mouth by a wooden frame, and the trawling depth is regulated by adjustment of the bridges. (Authors)

10235. Smith, William B. (North Carolina Wildlife Resources Comm., Raleigh, N. C.). 1968. ROANOKE BASS, *Ambloplites cavifrons* Cope. Progr. Fish-Cult., 30(3): 180.

The Roanoke bass (*Ambloplites cavifrons*) as taken from several headwaters of the Tar River Basin, is compared to the rock bass (*A. rupestris*). The Roanoke bass appears to outgrow its associated species, and studies have been undertaken to assess its value as a sport fish.

10236. Dahl, Frederick H. (Bur. of Commercial Fisheries Biological Station, Marquette, Mich.). 1968. A SURFACE TOW NET FOR COLLECTION OF PARASITIC-PHASE SEA LAMPREYS. Progr. Fish-Cult., 30(3): 183-184.

A surface tow net used to capture parasitic-phase sea lampreys in the wake of a slowly moving boat is described. The net caught more than 2,500 sea lampreys tagged and released in the St. Marys River, Lake Huron. (Auth.)

10237. Anderson, Richard O. (Bur. of Sport Fisheries and Wildlife, Univ. of Missouri, Columbia, Mo.). 1968. TRANSPORT OF GIZZARD SHAD. Progr. Fish-Cult., 30(3): 184.

As collected, adult gizzard shad (*Dorosoma cepedianum*) were placed in a tank of water containing salt and tertiary amyl alcohol and aerated with pure oxygen. They were then transferred to a holding net in fresh water for 24 hours. Salt and a light concentration of MS-222 were added to the water in the tanks in which 340 pounds were transported with a loss of 4 pounds.

10238. Blackburn, Robert D. (Crops Research Div., Agricultural Research Service, Dept. of Agriculture, Ft. Lauderdale, Fla.). 1968. WEED CONTROL IN FISH PONDS IN THE UNITED STATES. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5. pp. 1-17.

A brief review has been made of existing information on control of aquatic weeds in fish ponds in the U. S. A. Species of aquatic vegetation commonly found in ponds and methods of control are discussed. Preventative, fertilization, biological, mechanical and chemical methods of control are discussed, along with results and problems encountered when using each method. A few of the herbicides currently used in aquatic weed control are discussed individually along with factors important to the biologist, such as the weed species controlled, toxicity to fish and mammals, etc. Table I in the Appendix lists suggested control measures for some of the common aquatic weeds in fish ponds of the U. S. A. (Auth.)

10239. Lawrence, J. M. (Agricultural Experiment Station, Auburn Univ., Auburn, Ala.). 1968. AQUATIC WEED CONTROL IN FISH PONDS. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5. pp. 76-91.

Results of 30 years of aquatic weed control research in fish ponds at this Station are summarized. This summary includes a listing of important algae genera and aquatic weed species, and information on pond construction features of significance in aquatic weed control, as well as mechanical, biological, and chemical control techniques. Included in discussions on chemical control techniques are data on fish toxicity of each herbicide as well as effective rates of application for use under pond conditions. (Auth.)

10240. Avault, James W., Jr., R.O. Smitherman, and E.W. Shell (Auburn Univ., Agricultural Experiment Station, Auburn, Ala.). 1968. EVALUATION OF EIGHT SPECIES OF FISH FOR AQUATIC WEED CONTROL. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5. pp. 109-122.

A study was undertaken to determine the value of herbivorous fishes in biological control of aquatic weeds. Ctenopharyngodon idella controlled a wide variety of weeds when stocked in ponds at 49 to 99 per ha. Common carp, Cyprinus carpio, controlled filamentous algae and Eleocharis acicularis when stocked at 124 per ha. In this experiment common carp were not detrimental to fish populations when stocked at the above rate. Tilapia melanopleura controlled filamentous algae and a variety of higher plants when stocked at 2,470 to 2,940 per ha. At this stocking rate T. melanopleura did not produce adverse effects on other fishes. T. nilotica and T. mossambica showed little promise as weed control agents except for the control of filamentous algae. T. heudeloti did not feed appreciably on aquatic plants. Carassius auratus and Ictalurus punctatus when stocked at rates that would not interfere with other fish populations showed no potential for controlling aquatic weeds. (Authors)

10241. Fielding, James R. (Bur. of Sport Fisheries and Wildlife, Atlanta, Ga.). 1968. NEW SYSTEMS AND NEW FISHES FOR CULTURE IN THE UNITED STATES. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5. pp. 143-161.

Commercial pond culture for production of food fish is a recent development in the United States. Four new systems of commercial pond culture are described. Channel catfish are the most desirable species for fresh-water pond culture because of their efficient conversion, high production and acceptance by the consumer at above average prices. A net production of 2,423 kg per ha is reported for 252 days. Brackish-water pond culture is undeveloped; however, preliminary experiments on native species indicate that it is feasible. Shrimp production of 1,387 kg per ha in 4.5 months is reported. (Auth.)

10242. Meyer, Fred P. (Bur. of Sport Fisheries and Wildlife, Fish Farming Experimental Station, Stuttgart, Ark.). 1968. A REVIEW OF THE PARASITES AND DISEASES OF FISHES IN WARM-WATER PONDS IN NORTH AMERICA. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 290-318.

Disease problems of bacterial, viral, fungal, algal, helminth, copepod, and annelid origins are discussed in detail. The importance of each to the American fish culturist is discussed, its economic importance cited, and the developmental stages or species of fish most susceptible listed. Applied treatment and the limitations of each are given for the various diseases, along with references to important research works pertinent to each case. Personal experiences of the author, based on data accumulated in the diagnostic laboratory at the Fish Farming Experimental Station are included. Gaps in existing knowledge, short-comings of currently applied treatments, and promising areas for continued research are indicated. (Auth.)

10243. Rychlicki, Zbigniew (Dept. of Fish Biology and Breeding, Inst. of Animal Science, Krakow, Poland). 1968. ERADICATION OF Ichthyophthirius multifiliis IN CARP. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 361-364.

Quicklime was applied in carp ponds to control the Ichthyophthirius multifiliis infection. A dose of 3,000 kg of lime per ha administered in two lots proved safe for fish and destructive to the parasite. (Auth.)

10244. Smitherman, R. Oneal (Agricultural Experiment Station, Auburn Univ., Auburn, Ala.). 1968. EFFECT OF THE STRIGEID TREMATODE, Posthodiplostomum minimum, UPON GROWTH AND MORTALITY OF BLUEGILL, Lepomis macrochirus. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 380-388.

Studies were conducted to evaluate the effect of experimental infections of the digenetic trematodes, Posthodiplostomum minimum, upon growth and mortality of the bluegill, Lepomis macrochirus. Growth of fingerling bluegill over a 6-week period was not appreciably reduced when the fish were infected with an average of 103.3 metacercariae; however, average infection rates of 353.1 and 546.8 metacercariae per fish significantly reduced growth rates during a 32-week period. Mortality rate of bluegill infected with an average of 353.1 metacercariae was more than twice that of control fish over a 40-week period. (Auth.)

10245. Allison, Ray (Agricultural Experiment Station, Auburn, Univ., Auburn, Ala.). 1968. NEW CONTROL METHODS FOR Ichthyophthirius IN PONDS. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 389-392.

Channel catfish (Ictalurus punctatus) were used in experiments on the control of Ichthyophthirius multifiliis in glass aquaria and in earthen ponds. Four daily treatments with 1 ppm methylene blue resulted in an average of 70 percent survival over the untreated controls. Two treatments with 2 ppm on the first and fourth days of the experiment resulted in 50 percent survival. All of the control fish were dead on the fourth day of the experiment. A single earthen pond of 0.02 hectare stocked with 7,000 fingerling catfish was treated six times with 1 ppm methylene blue. Prior to the first application 2,150 fish died of a natural infection of Ichthyophthirius. The treatment resulted in 46.6 percent survival of the remaining population. Experiments with 0.1 and 0.05 ppm malachite green were conducted in aquaria to determine its efficacy for controlling Ichthyophthirius. Four replications of 10 fish each were used for each treatment. After 96 hours all of the control animals were dead; but there were no mortalities in any of the treated aquaria. An earthen pond of 0.10 hectare containing heavily parasitized channel catfish was treated with 0.1 ppm malachite green. After the first day following treatment, no mortalities occurred. Nine days after treatment 25 fish were examined and found to be free of the infection. A sample of 200 fish from this population held in aquaria did not develop ichthyophthiriasis. (Auth.)

10246. Rogers, Wilmer A. (Agricultural Experiment Station, Auburn Univ., Auburn, Ala.). 1968. THE BIOLOGY AND CONTROL OF THE ANCHOR WORM, Lernaea cyprinacea. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 393-398.

Life history studies of the anchor worm, Lernaea cyprinacea, showed three naupliar and six copepodid developmental stages. The life cycle of this species was completed in 17 days at 28° C. Control experiments conducted in aquaria using the organo-phosphate insecticide Dylox eliminated anchor worms with treatments of 0.1-0.5 ppm (active ingredient) repeated at two-week intervals. Field tests with Dylox at the rate of 0.25 ppm active ingredient eliminated parasitic larvae with three-weekly treatments, but a few adult anchor worms survived even after four weekly treatments at this rate. Plankton samples from the treated ponds indicated that Dylox had no apparent effect on phytoplankton. Little effect was noted on microcrustaceans and rotifers. (Auth.)

10247. Carothers, John L., and Ray Allison (Agricultural Experiment Station, Auburn Univ., Auburn, Ala.). 1968. CONTROL OF SNAILS BY THE REDEAR (SHELLCRACKER) SUNFISH. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 399-406.

Biological control of two species of native pond snails, Physa sp. and Lymnaea sp. was attempted using the redear sunfish, Lepomis microlophus (Günther). The feeding habits of redears were studied under varied conditions in aquaria. Snails alone were fed to redears at rates up to 8 percent of their body weight for seven days, and with few exceptions, all were eaten. When snails and midge (Chironomidae) larvae were fed at rates of 2 and 6 percent respectively, redears ate 73.3 percent of the snails offered. When the feeding rate of snails was doubled, fish ate 70 percent of the snails offered. Snails comprised 39.1 percent of the food eaten by redears when 16.6 percent of the available food consisted of snails and 83.4 percent

consisted of dragonfly nymphs. When 28.6 percent of the food given consisted of snails, they made up 48.6 percent of the total food eaten. Snail populations in plastic pools containing soil and six species of aquatic plants were reduced 80.6 to 98.9 percent within one day following the introduction of redear sunfish. The stomach contents of 63 redear sunfish taken from natural waters sparsely populated with snails were analyzed. Snails comprised 8.5 percent of the contents of the 49 stomachs containing food. (Authors)

10248. Swingle, H.S. (Auburn Univ., Agric. Experiment Station, Auburn, Ala.). 1968. FISH KILLS CAUSED BY PHYTOPLANKTON BLOOMS AND THEIR PREVENTION. Proc. of the World Symposium on Warm-Water Pond Fish Culture, FAO Fisheries Report No. 44, Vol. 5, pp. 407-411.

Growths of species of Microcystis, Anabaena, and occasionally Trachelomonas and Gymnodinium that form dense concentrations or scums in surface waters have been a primary cause of fish kills in ponds. Dense concentrations of these algae absorbed heat from sunlight, causing a sharp rise in temperature of surface waters. This in turn caused shallow stratification and light winds stirred only the top waters. The heavy concentrations of algae absorbed and reflected sunlight and consequently insufficient light for photosynthesis penetrated to depths below 1 m. Continuation of these conditions for approximately one week had the result that insufficient dissolved oxygen was present in waters below 1 m to support fish life. Subsequent upwelling of deeper oxygen-deficient waters caused distress or death of fish from lack of oxygen. Upwellings were caused by cold air masses, heavy winds or cold rains. Microcystis was the most common cause of such kills. Partial eradication of this alga with copper sulphate allowed deeper light penetration, deeper stratification and distribution of oxygen to greater depths, thus removing danger of a fish kill. While fish were in distress following upwelling, circulation and aeration of top waters with pumps or by stirring with boat and outboard motor prevented fish kills. (Auth.)

10249. Foerster, R.E. (Fisheries Research Board of Canada Biological Station, Nanaimo B.C., Canada). 1968. THE SOCKEYE SALMON, Oncorhynchus nerka. Fisheries Research Board of Canada Bulletin 162. 422 p.

The accumulation of forty years of detailed study of facts and statistics collected during the author's lifetime study of the life history, propagation, and ecology of the sockeye salmon. This book attempts to bring together all that is presently known about sockeye salmon. All studies carried out in the North Pacific sockeye salmon area have been reviewed and their results incorporated in order to present sockeye production under a variety of climatic and environmental conditions, and to assess overall survival, as well as at each stage of the life cycle from egg to adult.

10250. Strickland, J.D.H., and T.R. Parsons. 1968. A PRACTICAL HANDBOOK OF SEAWATER ANALYSIS. Fisheries Research Board of Canada Bulletin 167. 311 p.

This book is a completely revised and updated version of an earlier work by the same authors. New methods are described, and earlier ones are revised in order to meet the current demand for an authoritative reference book on seawater analysis.

10251. Pearcy, William G., and Lawrence F. Small (Dept. of Oceanography, Oregon State Univ., Corvallis, Oreg.). 1968. EFFECTS OF PRESSURE ON THE RESPIRATION OF VERTICALLY MIGRATING CRUSTACEANS. J. Fish. Res. Bd. Canada, 25(7): 1211-1216.

The rates of oxygen consumption of Euphausia pacifica Hansen, Thysanoessa spinifera Holmes, and Sergestes similis Hansen at 1 atm were compared with the rates at 16-50 atm. Differences were not significant, indicating little effect of pressure on respiratory rate. Apparently temperature has more influence than pressure on the respiration of these species during their diel vertical migrations. (Authors)

10252. Aspinwall, Nevin, and H. Tsuyuki (Univ. of British Columbia, Dept. of Zoology, Vancouver, B.C., Canada). 1968. INHERITANCE OF MUSCLE PROTEINS IN HYBRIDS BETWEEN THE REDSIDE SHINER (*Richardsonius balteatus*) AND THE PEAMOUTH CHUB (*Mylocheilus caurinum*). J. Fish. Res. Bd. Canada, 25(7): 1317-1322.

Selected muscle proteins were examined in artificially reared reidside shiners, *Richardsonius balteatus*, peamouth chubs, *Mylocheilus caurinum*, and in their F₁ and backcross hybrids to determine if they would be useful in identifying suspected natural hybrids. In reference to the proteins studied, *Mylocheilus* possesses a single zone designated "3"; *Richardsonius* also possesses a single zone designated "1", but of slower mobility. Artificially reared F₁ hybrids possess, in addition to both parental zones, a unique zone designated "2" which was assumed to be composed of components of zones 1 and 3. Some naturally occurring individuals suspected of being hybrids on the basis of morphological characters possessed a pattern identical to that of the experimentally produced F₁ hybrid (zones 1, 2, 3). Other suspected hybrids possessed either zones 1 and 2 or zones 2 and 3. These types of pattern corresponded to some of those produced by backcrosses to *Richardsonius* and *Mylocheilus*, respectively. The presence of both parental protein zones in the F₁ hybrid indicates that each polypeptide can be synthesized when only half the alleles of each parent is present. This characteristic of codominance can be useful in identifying suspected hybrid offspring of parents having different protein zones. Evidence is presented which supports the hypothesis that the proteins in question are genetically controlled by two loci, A and B, each of which exists in two allelic forms. (Authors)

10253. Bouck, G. R., and R. C. Ball (Dept. of Fisheries and Wildlife, Michigan State Univ., East Lansing, Mich.). 1968. COMPARATIVE ELECTROPHORETIC PATTERNS OF LACTATE DEHYDROGENASE IN THREE SPECIES OF TROUT. J. Fish. Res. Bd. Canada, 25(7): 1323-1331.

The isozyme patterns of lactate dehydrogenase (LDH) were examined in three species of trout using electrophoresis in polyacrylamide gel slabs. Each pattern was species specific and contained 15 isozymes of LDH, but a hybrid trout had at least 27 LDH isozymes. Tissue specificity of these isozymes was low except for skeletal muscle. These results suggest that LDH isozyme patterns could be used for taxonomic and diagnostic purposes. (Authors)

10254. Ophel, I. L., and J. M. Judd (Biology and Health Physics Div., Chalk River Nuclear Laboratories, Atomic Energy of Canada Ltd., Chalk River, Ont., Canada). 1968. MARKING FISH WITH STABLE STRONTIUM. J. Fish. Res. Bd. Canada, 25(7): 1333-1337.

Stable strontium is fed to fish in a Sr-rich, Ca-free synthetic food for a short period of time. Subsequent identification by flame emission photometry can be made using a single scale from a marked fish. One year after marking, scales from marked fish contain approximately 10 times as much Sr as those from control fish. There is no evidence of damage to fish due to their elevated Sr content. (Authors)

10255. Ryder, R. A. (Ontario Dept. of Lands and Forests, Port Arthur, Ont., Canada). 1968. DYNAMICS AND EXPLOITATION OF MATURE WALLEYES, *Stizostedion vitreum vitreum*, IN THE NIPIGON BAY REGION OF LAKE SUPERIOR. J. Fish. Res. Bd. Canada, 25(7): 1347-1376.

Walleye stocks in Nipigon Bay of Lake Superior were homogeneous with those in tributary inland waters but were discrete from Black Bay stocks. Returns from 2,200 tagged walleyes in Lake Superior and tributary inland waters between 1955 and 1958 varied from 7.8 to 31.0% for 2 years after release. The commercial fishery in Lake Superior recovered 64.9% of the tags, the sports fishery in inland waters captured 27.6%. Fish tagged in the Nipigon River travelled a mean distance of 11.8 miles from the point of release and were recovered in 191 days (average). Total mortality rates for Nipigon Bay walleyes were 55.0% (1955-57). Mature walleyes on the spawning grounds in the Nipigon River in 1957 were estimated at

22,000, and fish in Nipigon Bay over 14 inches (total length) the same year at 41,000. All male walleyes were mature at 15 inches and females at 18 inches. Walleyes exploitation rates increased with the decline of the lake trout fishery. Wounding and scarring rates by sea lampreys increased during 1955-57 but never exceeded 1.0% on adult walleyes. Severe pollution on the west side of Nipigon Bay originated from a kraft mill. High concentrations of total solids and dense sedimentation of wood fibers created an environment unfavorable to Hexagenia limbata and Pontoporeia affinis. The recent elimination of the walleye fishery in Nipigon Bay is most likely attributable to industrial pollution rather than to overexploitation or sea lamprey predation. (Auth.)

10256. Dryer, William R., and George R. King (Bur. of Commercial Fisheries Biological Lab., Ann Arbor, Mich.). 1968. REHABILITATION OF LAKE TROUT IN THE APOSTLE ISLANDS REGION OF LAKE SUPERIOR. J. Fish. Res. Bd. Canada, 25(7): 1377-1403.

Marked success of rehabilitation of lake trout in Lake Superior has been due principally to the control of the sea lamprey and closure of the lake trout fishery in 1962 and large-scale plantings of yearling lake trout in 1959-66. After the sea lamprey became established in the late 1940s, spawning stocks of lake trout began to decrease and were almost nonexistent by 1960-61. After control of the sea lamprey and closure of the commercial fishery for lake trout in 1962, the abundance of spawning stocks began to rise and reached the highest levels on record in 1964-66. Successful spawning in 1964 and 1965 was demonstrated by catches of age-0 lake trout in 1965 and 1966, the first evidence of natural reproduction since 1959. Plantings of hatchery-reared lake trout in Wisconsin waters of Lake Superior began in 1952. The percentage of hatchery-reared fish in catches of juvenile lake trout increased almost steadily from 1953 to 1965 (when nearly all were of hatchery origin). The abundance of juvenile fish increased from 1959 to 1962 and remained nearly constant in 1962-66. The success of lake trout plantings was highest in 1959-61 but generally declined after 1961; the success of the plantings was inversely related to the abundance of older lake trout. Annual increments of growth of hatchery-reared lake trout varied from 1.1 to 5.0 inches after planting. The average lengths of fish of identical age-groups varied according to year of capture, depth of water, and season. More than 65% of the season's growth of age-III lake trout took place after September. The findings indicated that the present rate of stocking lake trout may be higher than necessary to maintain optimum abundance. (Authors)

10257. Ricker, W.E., and H. H. Ross (Fisheries Research Board of Canada Biological Station, Nanaimo, B.C., Canada). 1968. NORTH AMERICAN SPECIES OF Taeniopteryx (PLECOPTERA, INSECTA). J. Fish. Res. Bd. Canada, 25(7): 1423-1439.

Keys, synonymy, descriptions, and distribution records are given for the eight American stonefly species of the genus Taeniopteryx Pictet, including the new species burksi, lonicera, meteui, and ugola. (Authors)

10258. Richard, Joseph D. (Inst. of Marine Science, Univ. of Miami, Miami, Fla.). 1968. FISH ATTRACTION WITH PULSED LOW-FREQUENCY SOUND. J. Fish. Res. Bd. Canada, 25(7): 1441-1452.

A series of tests were conducted to determine the effectiveness of pulsed low-frequency acoustic signals for attracting fishes. The acoustic signals were contrived to simulate the hydrodynamically generated disturbances normally associated with active predation. Underwater television was used to observe fish arrivals during both control and test periods. Demersal predatory fishes were successfully attracted although they habituated rapidly to the acoustic stimulus. Members of the families Serranidae, Lutjanidae, and Pomadasysidae were particularly well represented among the fishes attracted. Sharks were also attracted in considerable numbers. Herbivorous reef fishes, although common around the test site, were not attracted. Possible relationships between the test results and the hearing capabilities of fishes are discussed. It is concluded that acoustic attraction techniques have potential applications in certain existing commercial fisheries. (Auth.)

10259. Barnardson, Elton, F. E. Everest, and D. W. Chapman (Idaho Coop. Fish. Unit, College of Forestry, Univ. of Idaho, Moscow, Idaho). 1968. PERMANENCE OF STATION IN JUVENILE CHINOOK SALMON AND STEELHEAD TROUT. J. Fish. Res. Bd. Canada, 25(7): 1453-1464.

Daytime movements and night locations of juvenile steelhead trout (*Salmo gairdneri*) and night locations of spring-run chinook salmon (*Oncorhynchus tshawytscha*) were observed in Johnson Creek and the Lochsa River in Idaho during the summers of 1965 and 1966. The observations were made by branding fish and observing them subsequently under water. The distances between sequential sightings of branded steelhead within each day and over longer periods were recorded. In 161 sequential sightings of steelhead within each day in Johnson Creek 58% of the distances moved were less than 3 m. and 86% were less than 6 m. In 59 sequential sightings of branded steelhead on successive days in the Lochsa River and Johnson Creek 53% were less than 3 m. and 68% were less than 6 m. apart. In sightings of branded steelhead separated by 10-14 days 45% (25) of the sequential sightings were less than 3 m. and 63% were less than 6 m. apart. Movements of spring-run juvenile chinook salmon within each day were measured in a stream aquarium (16.5 m. long and 5.6 m. wide). Of 272 observed daily movements 65% were less than 5.6 m. Steelhead trout were inactive at night, occupying bottom areas of low velocity, usually inshore. During the day they were in areas of moderate current. Chinook salmon were observed at night to be both on the bottom and near the surface in quiet water, and on the bottom in flowing water. Chinook salmon were found at all depths in quiet water during the day. In winter, some steelhead trout were found in the substrate in the same area they occupied the previous summer. (Authors)

10260. Fagerlund, Ulf H. M., J. R. McBride, and Edward M. Donaldson (Fish. Res. Bd. of Canada, Vancouver Lab., Vancouver, B. C., Canada). 1968. EFFECT OF METOPIRONA ON PITUITARY-INTERRENAL FUNCTION IN TWO TELOSTEIS, SOCKEYE SALMON (*Oncorhynchus nerka*) AND RAINBOW TROUT (*Salmo gairdneri*). J. Fish. Res. Bd. Canada, 25(7): 1465-1474.

Metopirone (9K 4985), an inhibitor of 11β -hydroxylation of adrenocorticosteroids, was administered intramuscularly to adult castrated sockeye salmon (*Oncorhynchus nerka*) and intact rainbow trout (*Salmo gairdneri*). Marked hypertrophy of interrenal cells pointed to an increase in the activity of the interrenal tissue of both species. Increased cortisol concentrations in trout at low dosage levels of metopirone suggested that the drug was stressful. However, decreased concentrations at higher dosage levels in trout, and decreased cortisol concentrations in all salmon indicated that the drug was also exerting a marked inhibitory effect on 11β -hydroxylation. In salmon, a repository ACTH preparation (acthar) brought about interrenal hypertrophy similar to that produced by metopirone. Metopirone also induced degranulation and hyperplasia of the cells of the palisade-like layer in the rostral region of the pars distalis in both species of fish. These cells were the only cell type of the pars distalis that were stained with lead-haematoxylin. The evidence indicates that they are the corticotrops. (Authors)

10261. Gee, J. H. (Dept. of Zoology Univ. of Manitoba, Winnipeg, Man. Canada). 1968. ADJUSTMENT OF BUOYANCY BY LONGNOSE DACE (*Phrinichthys cataractae*) IN RELATION TO VELOCITY OF WATER. J. Fish. Res. Bd. Canada, 25(7): 1485-1496.

The buoyancy of longnose dace (*Phrinichthys cataractae*) is correlated with the velocity of water in which they are living. Swimbladders from fish collected in rapids of streams and rivers are smaller in volume than in those fish collected from still water. Laboratory experiments on yearling and older fish show that individuals alter their buoyancy by changing the volume of their swimbladder. Buoyancy depends on velocity of water and size of fish. Longnose dace adjust their buoyancy rapidly in response to changes in velocity of water. They can decrease their buoyancy to adapt to an increase in velocity of water in 3 hours. A complete adjustment requires 4 days. Fish with access to the surface can increase their buoyancy in response to reduced velocities by completely inflating

their swimbladders in less than 24 hours. Fish without access to the surface require 48 hours to complete the same adjustment. Thus, longnose dace have a functional gas gland even though they are physostomes. The gas gland does not function during the early stages of life after hatching. Alevins come to the surface to fill initially their swimbladders. The ability to adjust buoyancy rapidly is an adaption to life in rivers and streams by fishes that live mostly in swift-flowing waters but are sometimes forced to live temporarily in reduced current when the volume of water flowing is diminished. (Auth.)

10262. Donaldson, Edward M., Fumio Yamazaki, and W. Craig Clarke (Fish. Res. Bd. of Canada, Vancouver Lab., Vancouver, B.C., Canada). 1968. EFFECT OF HYPOPHYSECTOMY ON PLASMA OSMOLARITY IN GOLDFISH AND ITS REVERSAL BY OVINE PROLACTIN AND A PREPARATION OF SALMON PITUITARY "PROLACTIN". J. Fish. Res. Bd. Canada, 25(7): 1497-1500.

10263. Glenn, C. L., and F. J. Ward (Dept. of Zoology, Brandon Univ., Brandon, Man., Canada). 1968. "WET" WEIGHT AS A METHOD FOR MEASURING STOMACH CONTENTS OF WALLEYES, Stizostedion vitreum vitreum. J. Fish. Res. Bd. Canada, 25(7): 1505-1507.

10264. Royer, L. M., F. M. Atton, and J. -P. Guerrier (Saskatchewan Fisheries Lab., Saskatoon, Sask., Canada). 1968. AGE AND GROWTH OF LAKE STURGEON IN THE SASKATCHEWAN RIVER DELTA. J. Fish. Res. Bd. Canada, 25(7): 1511-1516.

10265. Knowles, Charles O., Suresh K. Arurkar, and James W. Hogan (Dept. of Entomology, Univ. of Missouri, Columbia, Mo.). 1968. ELECTROPHORETIC SEPARATION OF FISH BRAIN ESTERASES. J. Fish. Res. Bd. Canada, 25(7): 1517-1519.

10266. McDermott, L. A. (Dept. of Microbiology, Ontario Agricultural College, Univ. of Guelph, Guelph, Ont., Canada). 1968. Aeromonas SP. INFECTION IN GREAT LAKES LAMPREYS. J. Fish. Res. Bd. Canada, 25(7): 1521-1522.

10267. Nowlan, Sandra S., W. J. Dyer, and Doris I. Fraser (Fish. Res. Bd. of Canada, Halifax Lab., Halifax, N.S., Canada). 1968. PROBLEMS INVOLVED IN THE QUANTITATIVE EXTRACTION OF GLYCOGEN AND HIGH-ENERGY PHOSPHORUS COMPOUNDS IN FROZEN COD MUSCLE. J. Fish. Res. Bd. Canada, 25(8): 1525-1538.

Extraction of cod muscle with 0.3 N perchloric acid followed by digestion of the residue in potassium hydroxide yielded an average of 16% more total glycogen than did classical digestion with 30% KOH. However, the differences tended to be less at higher glycogen levels. It was suggested that glycogen may be partially degraded during digestion with KOH, although no glycogenolysis occurred during contact with alkali prior to heating. The proportion of residual glycogen not extracted by acid varied from 23% in unfrozen muscle to about 40% in liquid nitrogen-frozen and in slowly frozen muscle. Significant degradation of glycogen and high energy phosphorus compounds in frozen prerigor cod muscle was avoided by weighing samples in insulated beakers chilled by liquid nitrogen to prevent warming or thawing, and by homogenizing immediately on addition of acid extractant. Extraction with acid enabled the simultaneous determination of glycogen and phosphorus compounds on the same sample. Special sampling procedures were employed to reduce the sampling error due to variation in glycogen distribution along the fillet. (Authors)

10268. Tarr, H. L. A. (Fish. Res. Bd. of Canada, Vancouver, Lab., Vancouver, B.C., Canada). 1968. POSTMORTEM DEGRADATION OF GLYCOGEN AND STARCH IN FISH MUSCLE. J. Fish. Res. Bd. Canada, 25(8): 1539-1554.

Degradation of glycogen and starch in excised fish muscle blocks at 0-5° C postmortem was investigated by use of radioactive substrates. Separation of the

various metabolites in the stored muscles was accomplished by perchloric acid extraction, gel filtration, treatment with anion and cation exchange resins followed by appropriate elution methods, and paper chromatography. The results showed that glycogen is degraded by both hydrolytic (amylolytic) and phosphorolytic (Embsden-Myerhof) pathways, and that starch is similarly degraded but more slowly. The degradative pattern was not significantly altered by brief blending of the muscle. Though lactate and glucose usually predominated, dextrans (or nondegraded substrate), maltose, glucose 6-phosphate, hexose diphosphate, ribose 5-phosphate, and ribose were also recovered. Though results obtained with muscle from widely different fish species were in general rather similar, there were obvious quantitative differences which could possibly be attributed to a number of factors such as species differences, nutritional status, holding temperature, and state of maturation. The fact that labelled dextrans, glucose, and ribose were formed in muscle injected with radioactive lactate, suggested that all the reversible glycolytic enzymes and glycogen synthetase are functional in fish muscle blocks. (Auth.)

10269. Bilinski, E., and L. J. Gardner (Fish. Res. Bd. of Canada, Vancouver Lab., Vancouver, B.C., Canada). 1968. EFFECT OF STARVATION ON FREE FATTY ACID LEVEL IN BLOOD PLASMA AND MUSCULAR TISSUES OF RAINBOW TROUT (Salmo gairdneri). J. Fish. Res. Bd. Canada, 25(8): 1555-1560.

The concentration of free fatty acids (FFA) in blood plasma of rainbow trout (Salmo gairdneri) maintained without food for 1-70 days averaged 424 (range 160-1003) μ equivalents FFA per liter plasma. The effect of starvation on the level of plasma FFA was limited, showing a more significant increase during the first 2 weeks without food than during prolonged periods of starvation. FFA in lateral line muscle averaged 147 (range 27-258) μ equivalents per 100 g wet tissue and during starvation a trend generally similar to that found for plasma FFA was observed. Starvation had no effect on the amounts of FFA in white dorsal muscle which averages 37 (range 13-73) μ equivalents per 100 g wet tissue. The results are discussed in relation to the mechanism of utilization of fat reserve in fish. (Authors)

10270. Hogan, James W., and Charles O. Knowles (Fish-Pesticide Research Lab., Bur. of Sport Fisheries and Wildlife, Columbia, Mo.). 1968. DEGRADATION OF ORGANOPHOSPHATES BY FISH LIVER PHOSPHATASES. J. Fish. Res. Bd. Canada, 25(8): 1571-1579.

Liver homogenates of bluegill, Lepomis macrochirus Rafinesque, and channel catfish, Ictalurus punctatus (Walbaum), were shown by a manometric technique to contain soluble enzymes capable of degrading diisopropyl phosphorofluoridate (DFP) and 2,2-dichlorovinyl dimethyl phosphate (dichlorvos). Hydrolysis of the compounds was greatest in the presence of the manganic ion. Tentative identification of certain of the hydrolysis products suggested that cleavage of the anhydride bond was a degradation pathway for DFP and dichlorvos in vitro under the assay conditions employed. Substrate summation, inhibition, and activation experiments failed to clearly indicate more than a single enzyme hydrolyzing DFP and dichlorvos in the two fish. (Authors)

10271. Miles, S.G. (Inst. of Oceanography, Dalhousie Univ., Halifax, N.S., Canada). 1968. RHEOTAXIS OF ELVERS OF THE AMERICAN EEL (Anguilla rostrata) IN THE LABORATORY TO WATER FROM DIFFERENT STREAMS IN NOVA SCOTIA. J. Fish. Res. Bd. Canada, 25(8): 1591-1602.

In an experimental apparatus, elvers of the American eel (Anguilla rostrata) showed a stronger positive rheotaxis to fresh water than to salt water. The attractiveness of the fresh water was due to dissolved and particulate organic matter; these components were bio-degradable, heat stable, and nonvolatile. Four streams near Halifax, Nova Scotia, were tested, and were found to differ greatly in their attraction of elvers. Elvers were collected from each of three of these streams, and were not found to be attracted to their own stream water; elvers from one stream gave a greater rheotactic response than elvers from the other streams. The presence of adult eels in the water rendered it more attractive, whereas the presence of elvers made it less so. (Auth.)

10272. Ackman, R.G., C.S. Tocher, and J. McLachlan (Fish. Res. Bd. of Canada, Halifax Lab., Halifax, N.S., Canada). 1968. MARINE PHYTO-PLANKTER FATTY ACIDS. J. Fish. Res. Bd. Canada, 25(8): 1603-1620.

Twelve species of marine unicellular algae have been cultured under comparable conditions and the total fatty acids determined by gas-liquid chromatography. Some specific fatty acid relationships paralleling taxonomic groupings were detected but generally individual fatty acids within various algal classes showed large relative variations. The four Bacillariophyceae examined were notable for fatty acid compositions giving iodine values <150, whereas in eight other classes the iodine values were all approximately 200. It is suggested that 5,8,11,14,17-eicosapentaenoic acid, found to be a common algal longer-chain polyunsaturated fatty acid, is characteristically deposited in the lipids of filter-feeders ingesting unicellular algae. (Authors)

10273. Huang, Chau-Ting, and Cleveland P. Hickman, Jr. (Dept. of Zoology, Univ. of Alberta, Edmonton, Alta., Canada). 1968. BINDING OF INORGANIC IODIDE TO THE PLASMA PROTEINS OF TELEOST FISHES. J. Fish. Res. Bd. Canada, 25(8): 1651-1666.

The natural binding of inorganic iodide by plasma proteins was studied in 10 freshwater teleost fishes, 16 marine teleost fishes, 3 elasmobranchs, 1 amphibian, 1 reptile, 1 bird, 2 mammals, and 2 arthropods. Of these, significant binding existed only in species of the order Clupeiformes including Esox lucius (average 80.9% of plasma inorganic iodide was protein-bound at 20° C), Coregonus clupeaformis (average 80.3% bound), Salmo gairdneri (average 84.3% bound), and Thymallus arcticus (average 81.0% bound). Significant binding was not found in fish of the orders Cypriniformes, Perciformes, Pleuronectiformes, Batrachoidiformes, Gadiformes, Squaliformes, Chimaeriformes, and Rajiformes. Esox lucius and C. clupeaformis showed a small seasonal variation in binding capacity. The plasma of male fish bound significantly more iodide than did the plasma of female fish. Inorganic iodide was found to bind with a plasma albumin-like protein. The binding sites were presumably free cationic groups of basic amino acid residues on the protein molecules. Iodide binding was inhibited by NO₃⁻, SCN⁻, ClO₄⁻, and CCl₃COO⁻, but not affected by thiourea, thiouracil, and other halide ions. Binding energy was weak in both E. lucius (-5.98 Kcal/mole) and C. clupeaformis (-6.08 Kcal/mole). (Authors)

10274. Booke, Henry E. (Dept. of Biology, Yale Univ., New Haven, Conn.). 1968. CYTOTAXONOMIC STUDIES OF THE COREGONINE FISHES OF THE GREAT LAKES, USA: DNA AND KARYOTYPE ANALYSIS. J. Fish. Res. Bd. Canada, 25(8): 1667-1687.

Coregonine fishes are difficult taxonomically because they exhibit great plasticity in both morphological and physiological characters. The purpose of this study, based on the Great Lakes coregonine fishes, was to determine from cytogenetic parameters the possible basis for phenotypic plasticity as an approach to understanding systematic relationships within the family Salmonidae. "Nearness-of-relationship" among these fishes was judged by the percentage of guanine plus cytosine (G+C mole %) in DNA isolations (from livers) from eight Great Lakes plus one Canadian species of coregonines. Polyploidy as a factor in this group's evolution and speciation was examined by measuring and comparing, by microspectrophotometry, the amount of DNA per corneal epithelial cell for nine coregonine and one thymalline species. The karyotypes of seven whitefishes were determined from blastula materials as the morphology and count of chromosomes have been recognized as species-specific characters. There was a significant difference between the G+C values for species of Prosopium and Coregonus plus Stenodus. These data and those from other parameters cited possibly confirm the early dichotomy between Prosopium and Coregonus. There were no differences in G+C values for the species of Coregonus (true whitefish and cisco) and Stenodus. No one coregonine species had multiple units of the DNA amount nor chromosome number of another species. Therefore, polyploidy as a means of speciation in this group is not operating. A correlation between amount of DNA and chromosome

arm number is apparent. Karyotype analysis revealed a stabilization at the diploid number of 80 for species of Coregonus. Prosopium coulteri and P. cylindraceum have a diploid number of 82 and 78, respectively. The major differences among the species-specific karyotypes were in the number of chromosome arms with the more primitive species having higher numbers than the recent species. A hypothesis concerning the possible derivation of cisco from whitefish karyotypes was stated. The similarity of whitefish karyotypes has probably permitted introgression and geneflow in this group. Coregonine genera (Coregonus, Prosopium, and Stenodus) were defined on the basis of the new parameters studied. (Auth.)

10275. Kuty, Methil Narayan (Dept. of Zoology, Univ. of Toronto, Toronto, Ont., Canada). 1968. RESPIRATORY QUOTIENTS IN GOLDFISH AND RAINBOW TROUT. J. Fish. Res. Bd. Canada, 25(8): 1689-1728.

The respiratory quotients (R.Q.) of goldfish and rainbow trout were measured at 20° and 15° C, respectively under spontaneous and forced activity. In goldfish spontaneously active and acclimated to air saturation the R.Q. was 1.02 in ambient oxygen above 50% air saturation and rose to 1.94 below 25% air saturation. Rainbow trout under similar conditions displayed respective R.Q.'s of 0.96 and 1.4. The later R.Q. could be sustained only for a short time. In both species the metabolic rate dropped at oxygen concentrations below 50% air saturation but spontaneous activity remained high. Goldfish acclimated to 15% air saturation displayed the same R.Q. as unacclimated fish and thus did not display any increase in anaerobic capacity. When forced to swim steadily in water above 50% air saturation both species showed an initial anaerobic phase. This phase was less marked in the rainbow trout and was followed by an aerobic steady state except that at low swimming speeds the goldfish appeared to continuously derive some energy anaerobically. At oxygen concentrations below 50% air saturation the R.Q. of goldfish increased with decreasing concentration during steady swimming. At the single level of steady swimming effort at which comparisons were made, the R.Q. of goldfish did not change with acclimation to 15% air saturation but the rate of oxygen consumption fell to about 50% of the value before acclimation. The rainbow trout was not acclimated to low oxygen for any test. (Auth.)

10276. Applegate, Richard L., Alfred C. Fox, and Victor J. Starostka (Coop. Fishery Unit, South Dakota State Univ., Brookings, S.D.). 1968. A WATER CORE PLANKTON SAMPLER. J. Fish. Res. Bd. Canada, 25(8): 1741-1742.

10277. McAlice, Bernard J. (Ira C. Darling Center for Research, Teaching and Service, Univ. of Maine, Walpole, Me.). 1968. AN OCCURRENCE OF CILIATE RED WATER IN THE GULF OF MAINE. J. Fish. Res. Bd. Canada, 25(8): 1749-1751.

10278. Scott, J.S. (Fish. Res. Bd. of Canada, Biological Station, St. Andrews, N.B., Canada). 1968. MORPHOMETRICS, DISTRIBUTION, GROWTH, AND MATURITY OF OFFSHORE SAND LAUNCE (Ammodytes dubius) ON THE NOVA SCOTIA BANKS. J. Fish. Res. Bd. Canada, 25(9): 1775-1785.

A population of Ammodytes dubius occurs on the Nova Scotia banks, the fish being much larger than those reported previously for the species. The ranges of vertebral and anal fin ray numbers for A. dubius are extended. Research records of the launce, from catches and from stomach contents of predators, indicate that it is widely distributed over the banks throughout the year, but is concentrated in depths of 20-50 fathoms. Maturity data show that it is a winter spawner. A tentative growth curve, based on age-length determinations using otoliths, indicates that the growth pattern is similar to that of A. lanceolatus. The launce is shown to be an important item in the diet of cod and a constituent, in the egg or the adult stage, in the diets of many other commercially exploited fishes of the Nova Scotia banks. (Auth.)

10279. Macek, Kenneth J. (Dept. of Zoology, Univ. of New Hampshire, Durham, N.H.). 1968. REPRODUCTION IN BROOK TROUT (*Salvelinus fontinalis*) FED SUBLETHAL CONCENTRATIONS OF DDT. J. Fish. Res. Bd. Canada, 25(9): 1787-1796.

When sexually maturing yearling brook trout were fed for 156 days with DDT at rates that evidently caused no mortality, fish fed at the lower dosages produced more mature ova than untreated fish. Those fed at the highest dosage produced fewer mature ova than untreated fish. The size of the male fish at the end of the feeding period tended to increase according to dosage of DDT. In eggs and sac fry obtained from various mating combinations of gametes from the experimental groups, mortality was with one exception higher when at least one of the gametes came from treated fish than when they both came from untreated fish. A major portion of the mortality of sac fry in groups where the eggs came from treated fish occurred during the 15th week of development. This period coincided with the period of maximum utilization of yolk fat reported to occur in other salmonid fry, and indicated that insecticide residues in the eggs were released at this time and resulted in the observed mortality. The residue concentrations in the fish at the end of the feeding period were similar to those reported for wild fish. (Auth.)

10280. Gakstatter, Jack H. (Fed. Water Pollution Control Admin., Southeast Water Lab., Athens, Ga.). 1968. RATES OF ACCUMULATION OF ^{14}C -DIELDRIN RESIDUES IN TISSUES OF GOLDFISH EXPOSED TO A SINGLE SUBLETHAL DOSE OF ^{14}C -ALDRIN. J. Fish. Res. Bd. Canada, 25(9): 1797-1801.

Immediately after goldfish (*Carassius auratus* (Linnaeus)) had been exposed for 8 hours in a static system to 0.05 ppm of ^{14}C -aldrin, ^{14}C -dieldrin was detected in various tissues. The percentages that were dieldrin increased with time in all of the tissue studied until at 32 days they were 93.9% or more except for visceral fat. Except in visceral fat, 50 and 100% of the residues were dieldrin within 2.5-5.4 and 31.5-92.4 days respectively. For visceral fat the corresponding times were 46.9 and 14,733 days. (Auth.)

10281. Johnston, C.E., and J.G. Eales (Dept. of Biology, Univ. of New Brunswick, Fredericton, N.B., Canada). 1968. INFLUENCE OF TEMPERATURE AND PHOTOPERIOD ON GUANINE AND HYPOXANTHINE LEVELS IN SKIN AND SCALES OF ATLANTIC SALMON (*Salmo salar*) DURING PARR-SMOLT TRANSFORMATION. J. Fish. Res. Bd. Canada, 25(9): 1901-1909.

The influences of temperature and photoperiod on the purine (guanine, hypoxanthine) levels in skin and scale silvery layers of Atlantic salmon at parr-smolt transformation were assessed by holding 2-year-old parr from December to June under four controlled temperature and photoperiod regimes: NLNT, 8LNT, NL3T, and 8L3T (where NL = naturally lengthening daily photoperiod; 8L = 8-hr daily photoperiod; NT = temperature held at $3 \pm 1^\circ \text{C}$ until mid-March and then rising to 14°C in June; 3T = temperature maintained at $3 \pm 1^\circ \text{C}$ throughout). From December through to March, levels of both purines increased under all four regimes. From April through to June purine levels continued to increase but were greater under NT than 8T regimes, showing that temperature influences purine deposition. Photoperiod changes did not modify purine levels appreciably. Other factors presumably influence silvering since under 8L3T (sustained "winter" conditions) purine levels more than doubled between December and June. The guanine/hypoxanthine ratio, higher for skin than for scale silvery layers, changed little seasonally and showed negligible dependence on temperature and photoperiod. Visual assessment of the extent of silvering correlated closely with measured purine levels. Increases in the fresh weight of fish were similar under all four regimes but a more pronounced decrease in the coefficient of condition occurred under NT regimes. (Authors)

10282. Sweers, H.E. (Marine Sciences Branch, Dept. of Energy, Mines and Resources, Ottawa, Ont., Canada). 1968. TWO METHODS OF DESCRIBING THE "AVERAGE" VERTICAL TEMPERATURE DISTRIBUTION OF A LAKE. J. Fish. Res. Bd. Canada, 25(9): 1911-1922.

The "average" vertical temperature distribution of a stratified freshwater lake can be obtained from a series of samples by various techniques. Two of these are described: computation of the average temperature at different levels and computation of the average depth of a number of isotherms. It is concluded that the latter technique can, under certain conditions, give a more realistic approximation of the observed temperature profiles, especially in the thermocline region. (Auth.)

10283. Godfrey, H., D.D. Worlund, and H.T. Bilton (Fish. Res. Bd. of Canada, Biological Station, Nanaimo, B.C., Canada). 1968. TESTS ON THE ACCURACY OF AGEING CHINOOK SALMON (*Oncorhynchus tshawytscha*) FROM THEIR SCALES. J. Fish. Res. Bd. Canada, 25(9): 1971-1982.

The accuracy with which several readers determined the ages of adult chinook salmon from their scales averaged 75% in a test that used scales from fish of known ages. Their consistency in assigning the same age to a scale when presented with the same selection of scales on two occasions averaged 76%. In these tests the readers derived age composition arrays which were similar to the true age compositions of the two samples. When several pairs of readers assigned ages to a large number of scales from fish of unknown ages, agreement within pairs was good (roughly 75%), and among the pairs the derived age compositions were very similar. The levels of both accuracy and consistency achieved in these tests indicate that experienced personnel, using good scale-reading equipment, are able to produce age composition data that could be used as reliable parameters in chinook salmon population analyses. (Authors)

10284. McCauley, Robert W. (Dept. of Biology, Waterloo Lutheran Univ., Waterloo, Ont., Canada). 1968. SUGGESTED PHYSIOLOGICAL INTERACTION AMONG RAINBOW TROUT FINGERLINGS UNDERGOING THERMAL STRESS. J. Fish. Res. Bd. Canada, 25(9): 1983-1986.

10285. Lindsey, C.C. (Inst. of Fisheries, Univ. of British Columbia, Vancouver, B.C., Canada). 1968. TEMPERATURES OF RED AND WHITE MUSCLE IN RECENTLY CAUGHT MARLIN AND OTHER LARGE TROPICAL FISH. J. Fish. Res. Bd. Canada, 25(9): 1987-1992.

10286. Turner, C.E., and H.T. Bilton (Fish. Res. Bd. of Canada, Biological Station, Nanaimo, B.C., Canada). 1968. ANOTHER PINK SALMON (*Oncorhynchus gorbuscha*) IN ITS THIRD YEAR. J. Fish. Res. Bd. Canada, 25(9): 1993-1996.

10287. Ali, M.A., and M. Anctil (Dept. of Biology, Univ. of Montreal, Montreal, Que., Canada). 1968. RELATIONSHIP BETWEEN THE RETINAL STRUCTURE AND HABITAT OF *Stizostedion vitreum vitreum* AND *S. canadense*. (Corrélation entre la structure rétinienne et l'habitat chez *Stizostedion vitreum vitreum* et *S. canadense*.) J. Fish. Res. Bd. Canada, 25(9): 2001-2003.

Stizostedion v. vitreum and *S. canadense* are sympatric species and both show a high degree of negative phototropism. However, they inhabit quite different ecological niches. *Stizostedion v. vitreum* generally inhabits clear water, where it attains good rates of growth. It is primarily a crepuscular fish feeding at dawn and dusk. *Stizostedion canadense*, on the other hand, grows well only in turbid water and despite a superficially similar eye feeds more actively throughout the day. The retinæ of the two species resemble each other in structure except for the retinal epithelial pigment (REP). *Stizostedion v. vitreum* has more REP and less guanine whereas the inverse is true for *S. canadense*. This variation is in good correlation with the differences in habitat and behavior mentioned above. (Authors)

10288. Legault, Romeo-O, and Claude Delisle (Dept. of Biology, Univ. of Ottawa, Ottawa, Ont., Canada). 1968. THE SPAWNING OF A POPULATION OF GIANT SMELT, *Osmerus eperlanus mordax*, IN LAKE HENEY, GATINEAU COUNTY, QUEBEC. (La fraye d'une population d'éperlans géants, *Osmerus eperlanus mordax*, au lac Heney, Comté de Gatineau, Québec). J. Fish. Res. Bd. Canada, 25(9): 1813-1830.

Two sympatric smelt populations inhabit Lake Heney, Gatineau County, Quebec. This study deals only with the population which we call "giant" but a brief discussion on "small smelt—large smelt" theory is included. The data were obtained from 1,556 specimens collected with eight gillnets set up under the ice at one locality on Lake Heney, in February, March, and April 1967. The data permitted the determination of the time and site of spawning in the giant population. The time and site of spawning in the "dwarf" population was already known, and we found a marked difference in the spawning behavior and time of spawning of the two populations. The two populations are furthermore reproductively isolated. The sex ratio during the spawning period was closely followed and found to be similar to that of all other freshwater or marine smelts. A DeGiusti dredge, dragged along the bottom below the position of the gillnets immediately after the melting of the ice, permitted the collection of embryonic smelt eggs from a depth of 30-40 feet. The maturity index, relative fecundity, and intergonadal ratio was especially studied. Ovary weight at maturity represents in average one-quarter the total body weight, and testis weight one-fortieth the body weight. A 213-mm female lays an average of 42,460 eggs. The right ovary is 4.5 times smaller than the left one, and the right testis is on the average 3.8 times smaller than the left one. There is a direct relationship between total fecundity and length of mature females. This relation is expressed by the curve $\log E = 4.54 \log L + k$. (Authors)

10289. Simard, André, and Étienne Magnin (Dept. of Biology, Univ. of Montreal, Montreal, Que., Canada). 1968. AGE AND GROWTH OF MUSKELLUNGE, Esox masquinongy, IN FOUR LAKES IN QUEBEC. (Âge et croissance du maskinongé, Esox masquinongy, dans quatre lacs du Québec). J. Fish. Res. Bd. Canada, 25(9): 1831-1842.

Specimens were taken from two lakes where muskellunge is indigenous: Lake Saint-Francois (188 specimens) and Lake Saint-Louis (109 specimens), and from two others where it was introduced: Lake Saint-Joseph (44 specimens) and Lake Ouareau (12 specimens). The ages were determined from scale readings. Growth in length and in weight was identical for males and females from lakes Saint-Francois and Saint-Louis and there was no difference in growth observed in these same two lakes. Growth, however, was very different in lakes Saint-Joseph and Ouareau: during their 11th summer for instance, muskellunge from lakes Saint-Francois and Saint-Louis measured 1,112 mm, and weighed 10,511 g whereas those from Lake Saint-Joseph measured 1,024 mm and weighed 8,854 g and those from Lake Ouareau measured 914 mm and weighed 5,669 g. Our results are compared with those in the literature. (Authors)

10290. Floyd, Hilton M. (Bur. of Commercial Fisheries Exploratory Fishing and Gear Research Base, Pascagoula, Miss.). 1968. A TROTLINE FOR BLUE CRABS. U.S. Fish and Wildlife Service Fishery Leaflet 616. 5 p. Illus.

A method of using many kinds of bait on a trotline is presented. The gear is easy to make and use. (Auth.)

10291. Carter, Neal M. 1968. INDEX AND LIST OF TITLES, FISHERIES RESEARCH BOARD OF CANADA AND ASSOCIATED PUBLICATIONS, 1900-1964. Fisheries Research Board of Canada Bulletin 164. 649 p.

10292. Fish, G.R. 1968. AN EXAMINATION OF THE TROUT POPULATION OF FIVE LAKES NEAR ROTORUA, NEW ZEALAND. N.Z. J. mar. Freshwat. Res. 2(2): 333-362.

Five lakes, varying from 10 to 100 hectares in area and each containing an existing population of Salmo gairdneri, were gill-netted and stocked with tagged fish each year from 1960 to 1965 to determine the effect of regular stocking on the size and numbers of fish present. There was little natural spawning of trout in most of the lakes. Growth in length and weight of tagged fish was computed and an annual estimate of population calculated from the netting returns. Appendices give details of the statistical analyses of the data. Fish production has been

correlated with the trophic status of the lakes as indicated by their temperature and oxygen content. There was no clear relationship between lake size and trout production but trout production decreased as the environment became more eutrophic. Results also showed a close inverse relationship between numbers supported and average weight achieved by the trout. It is concluded that the angling potential of local lakes can be maintained despite the eutrophication resulting from intensive agricultural development of the catchments. These lakes will produce large-sized fish if the trout population is kept relatively small. Loss in weight in brown and rainbow trout as a result of spawning activities in local lakes and streams was found to be similar. Both male and female fish lost between 22 and 40 percent of their weight over a spawning period. This probably accounted for the observed low-condition factor among older fish in the lake populations. (Auth.)

10293. McDowall, R.M. 1968. THE PROPOSED INTRODUCTION OF THE LARGEMOUTH BLACK BASS Micropterus salmoides (Lacepede) INTO NEW ZEALAND. N.Z. J. mar. Freshwat. Res. 2(2): 149-161.

Known characteristics of the largemouth black bass, Micropterus salmoides (Lacépède), in its natural habitats in North America and as an introduction in other areas are discussed in relation to the suggestion that the fish should be introduced into New Zealand. It is concluded that much more research on the New Zealand ecosystems is necessary before a realistic assessment can be made of the likely effects of the predatory bass on indigenous fish and on trout fisheries. (Auth.)

10294. Croker, Robert A. (Dept. of Zoology, Univ. of New Hampshire, Durham, N.H.). 1968. DISTRIBUTION AND ABUNDANCE OF SOME INTERTIDAL SAND BEACH AMPHIPODS ACCOMPANYING THE PASSAGE OF TWO HURRICANES. Chesapeake Sci., 9(3): 157-162.

Macrofaunal dominant populations of intertidal haustoriid amphipods at Sapelo Island, Georgia, show little change in zonation accompanying the passage of two hurricanes despite observed changes in beach morphology. Fluctuations in abundance of two species were correlated with life cycle events. Some mortality of amphipods probably occurred where large volumes of freshwater overflowed the sand beach. Protection from surf by nearshore shoals, behavioral factors, and the increase in number of species on protected beaches, are important factors providing checks on violent fluctuations and displacement of haustoriid populations. (Auth.)

10295. Hanks, Robert W. (Bur. of Commercial Fisheries, Biological Lab., Oxford, Md.). 1968. BENTHIC COMMUNITY FORMATION IN A "NEW" MARINE ENVIRONMENT. Chesapeake Sci., 9(3): 163-172.

Sequence of invasion of estuarine benthic organisms into a man-made pond was followed over a 2-year period. Dominant animals established early and developed a Mya-Macoma-Nereis association similar to that in nearby estuarine waters. Estimated biomass, faunal abundance, and growth measurements indicate that the benthic populations were near maximum levels within the first year, and that a stable association continued through the second year. Control of benthic populations will be essential if maximum production from selected food organisms is to be realized in artificial ponds. (Auth.)

10296. Bayley, Suzanne, Harvey Rabin, and Charles H. Southwick (Dept. of Pathobiology, Johns Hopkins Univ., Baltimore, Md.). 1968. RECENT DECLINE IN THE DISTRIBUTION AND ABUNDANCE OF EURASIAN MILFOIL IN CHESAPEAKE BAY. Chesapeake Sci., 9(3): 173-181.

Eurasian water milfoil (Myriophyllum spicatum L.) declined significantly in Chesapeake Bay from 1965 to 1967. This decline generally exceeded 95%, and was associated with several pathologic conditions, previously named Northeast disease and Lake Venice disease. We believe that these pathologic conditions have been responsible for the decline. No study of Lake Venice condition has yet been undertaken, but this paper presents evidence that Northeast condition is an

infectious disease. Northeast disease symptoms can be transmitted in the laboratory by a bacteriologically sterile filtrate passed through a 0.2 μ filter. This indicates a virus, virus-like particle, or a toxin as the etiologic agent. The primary pathogen is probably a virus, and the evidence for this will be presented in a later paper. Gram-negative bacilli obtained from diseased milfoil probably represent secondary infections. In September 1967, diseased milfoil showed a resurgence of growth and successfully flowered in several areas of the Bay. This may represent the development of genetic resistance to the pathogen, or it may be a natural cyclic pattern with reduced virulence of the pathogen. In November 1967, however, milfoil in Middle River collapsed to a greater extent than expected from normal winter kill, and that remaining was in very poor condition. (Authors)

10297. Vernick, Sanford H., and George B. Chapman (Dept. of Biology, Georgetown Univ., Washington, D.C.). 1968. ULTRASTRUCTURE OF AXILLARY GLANDS OF THE TOADFISH *Opsanus tau*. Chesapeake Sci., 9(3): 182-197.

The toadfish axillary glands are flattened pouches bilaterally situated close to the surface of the skin, in the axil of pectoral fins. Each gland has a large lumen opening to the external environment. The epithelial lining is thrown into folds and consists of mucous cells, epithelial cells, and huge flask-shaped clavate cells. Deep to the luminal lining is dense connective tissue containing blood vessels and nerves. Electron microscopy reveals that the clavate cells have a central vacuole containing a secretory product. In addition, hitherto undescribed membrane-limited "blebs" with a content density and texture similar to that of the product project inward from the vacuolar membrane. The cytoplasm, which contains vesicles and tubules of agranular or sparsely granular endoplasmic reticulum and a large nucleus, is relegated by the secretion to the periphery of the cell. The bordering epithelial cells are characterized by dilated cisternae of granular endoplasmic reticulum, membrane-limited granules, presumably secretory in nature, and large finger-like projections bounded by a thick basement membrane. These projections extend into the underlying connective tissue. Both the epithelial cells and the endothelial cells of the surrounding blood vessels exhibit a large number of pinocytotic vesicles. The method of release of the secretion and the function of the gland are as yet undetermined. (Authors)

10298. Smith, M.W. (Fish. Res. Bd. of Canada Biological Station, St. Andrews, N.B., Canada). 1968. FERTILIZATION AND PREDATOR CONTROL TO INCREASE GROWTH RATE AND YIELD OF TROUT IN A NATURAL LAKE. J. Fish. Res. Bd. Canada, 25(10): 2011-2036.

Enrichment in 1946 of Crecy Lake (20 ha; mean depth, 2.4 m), New Brunswick, with commercial fertilizers to provide 210 ppb of nitrogen (N), 390 ppb of phosphorus (P), and 270 ppb of potassium (K) had increased the growth rates of native and planted brook trout. In further studies, control of predation by fish-eating birds and mammals and reduction in number of eels, along with another application of fertilizers in 1951, improved the percentages of planted brook trout taken by anglers. Maximum percentages before and after predators were controlled were 17 and 88 for planted yearlings and 4 and 42 for planted underyearlings. Yields of planted trout to anglers and catches per unit effort improved commensurately. Autumn-stocked yearlings were largely (96%) angled in April before appreciable growth was made in the lake. Increases in yields of trout flesh produced in the lake resulted largely from the growth and higher survival of planted underyearlings. Harvested weights were greater than weights of plantings only when 16% or more of planted underyearlings were angled. When underyearling and yearling rainbow trout were planted instead of brook trout, with a third fertilization in 1959 and continued predator control, they grew faster than brook trout of comparable size. Rainbow trout produced more fish flesh in the lake than brook trout when the percentage returns to anglers for the two species were similar. However, the percentage return to the anglers from most plantings of underyearling rainbow trout was low, with the net result that the rainbow trout did not provide as consistently good angling as the brook trout nor did they utilize the productive capacity of the lake more effectively. Brook and rainbow trout spawned in the littoral areas of

the lake. However, yields of naturally reared trout were poor, particularly when the survival of planted trout was high. Killifish increased in numbers with fertilization, with or without predator control. Cyprinids were much less abundant than killifish, and sticklebacks disappeared from the lake. (Auth.)

10299. Stockner, John G. (Dept. of Zoology, Univ. of Washington, Seattle, Wash.). 1968. ALGAL GROWTH AND PRIMARY PRODUCTIVITY IN A THERMAL STREAM. J. Fish. Res. Bd. Canada, 25(10): 2037-2058.

Estimates of primary production and respiration of cyanophycean algal species growing in the run-off stream of a hot spring (37° C) were obtained throughout 1966 using the diurnal oxygen curve technique. Rates of gross primary production were slightly higher than published values from other aquatic ecosystems, but were less than recent estimates from hot springs in Yellowstone and Mount Lassen National Parks using the C₁₄ uptake method. Production/respiration ratios were calculated and ranged from 1.1 to 5.0. The effect of photosynthesis on the ionic concentration of influent and effluent water was noted, together with morphological changes in the algal mat as the growing season progressed. Changes in algal standing stock were studied in 1964 and 1965, together with growth rates from denuded areas by two methods of harvest. In both years the most rapid growth was recorded in May and June, whereas during the winter months growth was negligible. Maximum values of primary production in May and June 1966 coincided with these maximum growth periods. Significant differences in growth rates between years were thought to be due to several factors; most notably, harvest methods and auto-inhibitory toxins produced by layers of senescent cells composing the "mature" algal mat. Energy losses due to algal export and grazing are discussed in relation to the dynamics of the mat, and an annual energy budget is derived from estimates obtained in 1966. (Auth.)

10300. Addison, R.F., R.G. Ackman, and J. Hingley (Fish. Res. Bd. of Canada, Halifax Lab., Halifax, N.S., Canada). 1968. DISTRIBUTION OF FATTY ACIDS IN COD FLESH LIPIDS. J. Fish. Res. Bd. Canada, 25(10): 2083-2090.

Cod flesh lipids were separated by silicic acid chromatography into eight fractions, and the fatty acid distribution in five of these was examined by gas-liquid chromatography (GLC). As compared with the fatty acid composition of total flesh lipids, sterol esters contained less 16:0 but more 20:5w3; ethanolamine phosphatides contained less 16:0, less 20:5w3, but more 22:6w3; serine phosphatides contained less 16:0 and less 20:5w3 but more 18:0; and choline phosphatides had a fatty acid composition roughly similar to that of total flesh lipid but containing slightly more 16:0 and 20:5w3 and less 22:6w3. In fatty acid composition, the triglycerides more closely resembled liver lipid than any of the flesh lipid fractions. (Authors)

10301. Qadri, S.U. (Dept. of Biology, Univ. of Ottawa, Ottawa, Ont., Canada). 1968. GROWTH AND REPRODUCTION OF THE LAKE WHITEFISH, Coregonus clupeaformis, IN LAC LA RONGE, SASKATCHEWAN. J. Fish. Res. Bd. Canada, 25(10): 2091-2100.

In Lac la Ronge the lake whitefish (Coregonus clupeaformis (Mitchill)) spawned from late October until the middle of November at ages of 8 years and over. The growing season lasted from late May to early October and young fish grew faster than older ones and tended to have a longer growing season. Ages for 1,604 fish taken during 4 years showed that they grew to a fork length of about 16 inches in 10 years, the rate being slower than for lake whitefish in other large lakes in North America. The length-weight relationships were linear: for the open lake, $\log W = 3.48 \log L - 3.93$, and for Hunter Bay, $\log W = 3.26 \log L - 3.66$. The males matured a little earlier than females and their life span was somewhat shorter. The sex ratio was approximately 1:1. (Auth.)

10302. Reimers, Paul E. (Fish Comm. Oreg., Port Orford, Oreg.). 1968. SOCIAL BEHAVIOR AMONG JUVENILE FALL CHINOOK SALMON. J. Fish. Res. Bd. Canada, 25(9): 2005-2008.

10303. Rivas, Luis R. (Bur. of Commercial Fisheries Exploratory Fishing and Gear Research Base, Pascagoula, Miss.). 1968. FISHERMEN'S ATLAS OF MONTHLY SEA SURFACE TEMPERATURES FOR THE GULF OF MEXICO. U.S. Fish and Wildlife Service Circular 300. 33 p. Charts (27).

This atlas was prepared in response to interest expressed by the Gulf fishing industry for surface temperature information. It shows that sea surface temperatures fluctuate greatly seasonally and latitudinally with a yearly average of 77° F. This temperature fluctuation causes a seasonal fluctuation in the composition of the shallow-water fauna in the northern Gulf. The atlas also shows that surface temperatures extend deeper in winter than in summer and that upwelling occurs along the north coast of Yucatan during summer. In addition to monthly maps for mean surface isotherms, monthly maps for maximum, minimum, and average surface temperatures are also given. (Auth.)

10304. Hogman, Walter J. (Bur. of Commercial Fisheries, Ann Arbor, Mich.). 1968. ANNULUS FORMATION ON SCALES OF FOUR SPECIES OF COREGONIDS REARED UNDER ARTIFICIAL CONDITIONS. J. Fish. Res. Bd. Canada, 25(10): 2111-2122.

Scales from known-age coregonids reared in the laboratory were examined to determine when annuli formed and to learn possible factors of their formation. Scales were taken monthly from marked fish for periods up to 21 months. Scales were also examined from fish that died and from preserved specimens of young-of-the-year for each species. Two marks formed on almost all scales each calendar year. The stronger formed during March-April and the weaker in October-November. Both marks had all the usual characteristics of an annulus but the spring mark was considered the annulus and the fall mark an accessory check. The annulus formed during a period of constant temperatures and of little change in growth or increasing growth. The accessory check formed during a period of declining temperatures (1-5° F, or 0.6-2.8°C, per month) and of little change in growth or declining growth. Most fish grew throughout the winter; the only exceptions were one bloater (*Coregonus hoyi*) and several of the largest lake whitefish (*C. clupeaformis*). Fish were always given all the food they would eat to eliminate availability of food as a factor of mark formation. The temperature of the water during the winter ($50 \pm 0.3^\circ \text{F}$; $10.0 \pm 0.2^\circ \text{C}$) did not arrest metabolic activity. The growth rate was related more closely to day length than to other variables examined. (Auth.)

10305. Miles, S.G. (Inst. of Oceanography, Dalhousie Univ., Halifax, N.S., Canada). 1968. LABORATORY EXPERIMENTS ON THE ORIENTATION OF THE ADULT AMERICAN EEL, *Anguilla rostrata*. J. Fish. Res. Bd. Canada, 25(10): 2143-2155.

Adult American eels, *Anguilla rostrata*, caught on their spawning migration downriver, were filmed while in a circular tank, and the orientation of the eels was analysed by determining the direction of alignment of each eel in each frame of the time-lapse film. When allowed a view only of the sky, the eels oriented southward, in the direction of their supposed breeding area in the region of the Sargasso Sea. This southward orientation continued even if the eels were denied a view of the sky, provided they were subject to the diel rhythm of light-dark. Thus the eel seems capable of noncelestial orientation; the physical basis of this is not known. (Auth.)

10306. Murray, A.R. (Fish. Res. Bd. of Canada, Biological Station, St. John's, Nfld., Canada). 1968. SMOLT SURVIVAL AND ADULT UTILIZATION OF LITTLE CODROY RIVER, NEWFOUNDLAND, ATLANTIC SALMON. J. Fish. Res. Bd. Canada, 25(10): 2165-2218.

Between 1954 and 1961, seaward-migrating Atlantic salmon smolts were marked by the removal of their dorsal and adipose fins and released from the counting fence in the estuary of the Little Codroy River, Newfoundland, to determine their survival to, and utilization as, adults. Not all smolts were marked: in 1957 and 1958, about half, and in 1959, none were marked to assess the effects of marking on survival; in 1962, smolts were counted without being handled in a

specially designed trap to assess the effects of handling on survival. A total of 61,394 smolts were finclipped; 523 marked adults (0.82% of the smolts marked) returned to the fence, and 876 marked adults (1.47%) were estimated to have been taken by the commercial fishery in Newfoundland and Labrador. In addition, there was an unknown but probably large number of grilse landed that did not get into commercial channels and so were not sampled. Five age-groups of smolts migrated, but two of these were scarce and only three were found among the adult survivors. These were age-2 smolts (1.79% of the smolts marked), age-3 smolts (2.43%), and age-4 smolts (1.64%). Three sea-age groups were represented among the recorded survivors: grilse (0.96% of the smolts marked), 2 sea-year salmon (1.21%), and 3 sea-year salmon (0.07%). About 62% of the recorded survivors were utilized by the commercial fishery, 4% by anglers on the Little Codroy, and the remaining 34% escaped and may have spawned. The commercial fishery is estimated to have taken 48% of the grilse (plus some unrecorded grilse), 75% of the 2 sea-year salmon, and 43% of the 3 sea-year salmon. The handicap created by the loss of the dorsal and adipose fins and defined by the ratio of the instantaneous mortality rates of marked and unmarked fish was estimated to be 1.10. Handling smolts was estimated to cause an immediate instantaneous mortality of 0.23. The overall average survival rate, conservatively adjusted, becomes 3.64%, that is, 2,235 adult salmon would have survived from the migration of 61,394 smolts if they had not been handled and marked. However, if an estimate of unrecorded grilse be added, and a greater adjustment made for marking mortality, the survival rate becomes 9.42%. In addition to handling and marking, smolt survival also appears to have been affected by the size, age, and number of smolts migrating, as well as by the mark itself. Returns of Little Codroy smolts to the fence were lower than returns of salmon with missing adipose and ventral fins reported from several other streams. (Auth.)

10307. Sheri, A. N., and G. Power (Dept. of Biology, Univ. of Waterloo, Waterloo, Ont., Canada). 1968. REPRODUCTION OF WHITE PERCH, Roccus americanus, IN THE BAY OF QUINTE, LAKE ONTARIO. J. Fish. Res. Bd. Canada, 25(10): 2225-2231.

Reports on the age and size at maturity, sex ratios, spawning season, and fecundity of white perch.

10308. Duncan, Richard N., and Ivan J. Donaldson (Bur. Commercial Fisheries, Biological Lab., Seattle, Wash.). 1968. TATTOO-MARKING OF FINGERLING SALMONS WITH FLUORESCENT PIGMENTS. J. Fish. Res. Bd. Canada, 25(10): 2233-2236.

10309. Pletcher, F. T. (Vancouver City College, Vancouver, B. C., Canada). 1968. A SUBCUTANEOUS DART TAG FOR FISH. J. Fish. Res. Bd. Canada, 25(10): 2237-2240.

10310. Kennedy, W. A. (Fish. Res. Bd. of Canada, Biological Station, Nanaimo, B. C., Canada). 1968. EFFECT OF THE FP-66 TAG ON SABLEFISH GROWTH. J. Fish. Res. Bd. Canada, 25(10): 2247-2249.

10311. Budd, J. C., F. E. J. Fry, and J. B. Smith (Research Branch, Ontario Dept. of Lands and Forests, Maple, Ont., Canada). 1968. SURVIVAL OF MARKED LAKE TROUT IN LAKE MANITOU, MANITOULIN ISLAND, ONTARIO. J. Fish. Res. Bd. Canada, 25(11): 2257-2268.

Lake trout (491 in all), Salvelinus namaycush, planted as yearlings in Lake Manitou in 1952 were tagged at age VII when taken in trap nets during spawntaking operations. At the same time 259 native adult trout of unknown age were also tagged. In spawntaking operations in subsequent years tag numbers were noted for tagged fish recaptured and the fish returned to the lake after normal spawntaking. Both groups were estimated to have suffered a decrement of 25% per year. The lake trout planted were given a distinctive fin clip on planting so that comparisons of recaptures of tagged and untagged planted fish permitted estimates of

the survival of the total plant. The mean annual mortality rate from the time of planting was also estimated at 25%. Trout planted later appeared to have suffered a similar mortality rate. Observations on planted lake trout of known age indicated that the peak age for first spawning in females was age VI. There is no predation by sea lamprey in Lake Manitou. (Authors)

10312. Greer, G. L., and U. Paim (Dept. of Biology, Univ. of New Brunswick, Fredericton, N.B., Canada). 1968. DEGRADATION OF DDT IN ATLANTIC SALMON (*Salmo salar*). J. Fish. Res. Bd. Canada, 25(11): 2321-2326.

As indicated by thin-layer chromatography, hatchery-reared Atlantic salmon parr degraded DDT, absorbed from aqueous suspensions to DDE and TDE within 9 hours. DDT adsorbed on external surfaces of the salmon was not degraded. (Authors)

10313. Loring, D. H., and D. J. G. Nota (Fish. Res. Bd. of Canada, Marine Ecology Lab., Bedford Inst., Dartmouth, N.S., Canada). 1968. OCCURRENCE AND SIGNIFICANCE OF IRON, MANGANESE, AND TITANIUM IN GLACIAL MARINE SEDIMENTS FROM THE ESTUARY OF THE ST. LAWRENCE RIVER. J. Fish. Res. Bd. Canada, 25(11): 2327-2347.

In glacial marine sediments from the St. Lawrence estuary, iron varies between 1.32 and 5.42%, manganese between 0.043 and 0.28%, and titanium between 0.31 and 0.64%. The regional distributions of these elements are related to sediment texture. Analyses of individual sediment size-fractions show that Fe, Mn, and Ti concentrations generally increase with decreasing grain size. Variations in elemental ratios between the different grades suggests that not all of the Fe and Mn is located in detrital silicate minerals. Dithionite extraction of selected sediments resulted in preferential dissolution of 3-16% of the total iron, presumably that derived from amorphous and crystalline iron oxides and from sorbed material. Hydroxylamine-hydrochloride removed 5-60% of the total manganese, presumably that derived from exchangeable Mn, easily reducible Mn oxides, and sorbed Mn material. The soluble fraction is highest in freshly deposited pelites from the center of the estuary. Soluble Fe and Mn occur as oxide films on the particles deposited from suspension, and the amount held depends on rate of deposition and on the physicochemical conditions in the waters and in the sediments. In contrast, Ti occurs in detrital minerals and accumulates at the same rate as detrital sedimentary material. It is unaffected by environmental changes. This investigation shows that, despite the derivation of the sedimentary material from the Canadian Shield predominantly by nonchemical erosional processes, small but significant chemical modification of iron- and manganese-bearing material is taking place in response to present physicochemical conditions. (Authors)

10314. Cushing, D. H. (Fisheries Lab., Ministry of Agriculture, Fisheries and Food, Lowestoft, England). 1968. DIRECT ESTIMATION OF A FISH POPULATION ACOUSTICALLY. J. Fish. Res. Bd. Canada, 25(11): 2349-2364.

A method is described of estimating fish stocks by length-groups acoustically. Hake, off southern Africa, were recorded as individuals on the paper record of a Kelvin Hughes "Humber" echo sounder down to 350 fath. Signal strengths of single fishes were observed on the cathode ray tube and the target strengths of fishes are known; estimates of fish sizes were made. The signals were considered as being received from a mean angle (to the axis of transmission) in the volume insonified. Hence, average target strengths, average numbers/unit volume, and average heights above the sea bed were calculated. The echo survey made between Cape Town and Walvis Bay was expressed as numbers of fish/unit volume in a range gate of 1 or 4 fath above the sea bed. A length distribution of the hake stock was derived. (Auth.)

10315. Division of Fishery Research, Bureau of Sport Fisheries and Wildlife. 1968. PROGRESS IN SPORT FISHERY RESEARCH 1967. Bureau of Sport Fisheries and Wildlife Resource Publication 64. 220 p.

10316. Symons, Philip E. K. (Fish. Res. Bd. of Canada Biological Station, St. Andrews, N.B., Canada). 1968. INCREASE IN AGGRESSION AND IN STRENGTH OF THE SOCIAL HIERARCHY AMONG JUVENILE ATLANTIC SALMON DEPRIVED OF FOOD. J. Fish. Res. Bd. Canada, 25(11): 2387-2401.

Aggressive behavior of Atlantic salmon (*Salmo salar*) parr, tested in groups of eight, was greater during 3 days of deprivation of food than during 3 days of feeding. Frontal and lateral displaying appeared to increase more than charging and nipping. Increased aggression was only partly a result of increased locomotion, and therefore was partly a direct effect of hunger. Strong social hierarchies developed, larger fish nipping smaller ones more than the reverse. The correlation between size and hierarchical status was usually sufficient to account for the strength of hierarchy observed. Upon deprivation of food the dominant of any pair of socially unequal fish on the average increased its nipping of the subordinate. The nipping rate of dominants by subordinates did not change consistently; many low ranking fish decreased their nipping rate upon deprivation. These results would strengthen hierarchies during deprivation. Initiation of attacks by small fish, as opposed to nipping, increased consistently during deprivation. Nipping was more frequent between fish of equal status and size than between fish of unequal status or size. This could have accounted for the strength of hierarchies in groups in which the correlation between size and position was insufficient to do so. The increase in aggression upon food deprivation could function to increase the size of feeding territories when food is scarce. This and the strengthening of hierarchies would cause emigration of some fish from the area. Concentration of aggression between fish of equal size and status could permit parr of different ages to coexist. (Auth.)

10317. Vanstone, W. E., and J. R. Markert (Fish. Res. Bd. of Canada, Vancouver Lab., Vancouver, B. C., Canada). 1968. SOME MORPHOLOGICAL AND BIOCHEMICAL CHANGES IN COHO SALMON, *Oncorhynchus kisutch*, DURING PARR-SMOLT TRANSFORMATION. J. Fish. Res. Bd. Canada, 25(11): 2403-2418.

Growth rates and changes in some chemical constituents were investigated in laboratory-reared and wild coho salmon in the pre-smolt, smolting, and early post-smolt stages of their life cycles. Laboratory-reared pre-smolts of coho salmon continued to grow during fall and early winter but at an ever diminishing rate. During late winter, spring, and early summer, growth in both length and weight of these fish was exponential with time. In wild coho pre-smolts there was no apparent winter growth but, with the onset of warmer waters and longer day lengths in the spring, growth in both length and weight became exponential with time. Exponential growth continued in wild post-smolts held in seawater pens but at a slower rate than during smolting. It is postulated that the power b in the weight-length formula $W = aL^b$ is approximately 3.2 and that during smolting, when the fish are becoming more streamlined, the parameter a decreases from approximately 7.5 to about 6.2. Guanine levels in belly skin, which appeared to be related to lighting conditions and physiological state of the fish rather than to length or weight, increased during smolting to about $6 \mu\text{g}/\text{mm}^2$ skin and remained at these levels. In pre-smolt laboratory-reared fish total lipid increased with increasing growth. With further weight increases during exponential growth, the weight of lipid remained relatively constant and the amount of lipid per unit weight decreased. A decrease in percent lipid did not occur in wild fish. Total moisture, dry material, and nitrogen were linearly related to weight in the size-range investigated, but a sharp inflection in each least-square fit line occurred for moisture and dry material at a fish weight of 15 g and for total nitrogen at 7.5 g. These shifts in composition were related to fish size rather than to age, environment, or physiological state. During exponential growth, moisture, dry material, and nitrogen increased with increasing weight but whereas moisture increased at a slower rate than weight, solids and nitrogen increased more rapidly. (Authors)

10318. Wissing, Thomas E., and Arthur D. Hasler (Laboratory of Limnology, Univ. of Wisconsin, Madison, Wisc.). 1968. CALORIFIC VALUES OF SOME INVERTEBRATES IN LAKE MENDOTA, WISCONSIN. J. Fish. Res. Bd. Canada, 25(11): 2515-2518.

10319. White, H. C., and J. C. Medcof (Fish. Res. Bd. of Canada, Biological Station, St. Andrews, N.B., Canada). 1968. ATLANTIC SALMON SCALES AS RECORDS OF SPAWNING HISTORY. J. Fish. Res. Bd. Canada, 25(11): 2439-2441.

A female sea-run Salmo salar L. was caught in an experimental trap in East Apple River, Nova Scotia, during her upstream migration in October 1934. She was captured again in the same trap in 1935 and 1936. Counts of spawning marks on different scales from the same samples were inconsistent among themselves and with the history of the fish as shown by trapping records. Scale readings alone do not give a dependable estimate of the number of times a salmon has spawned if it has spawned two or more times. (Authors)

10320. Macek, Kenneth J. (Dept. of Zoology, Univ. of New Hampshire, Durham, N.H.). 1968. GROWTH AND RESISTANCE TO STRESS IN BROOK TROUT FED SUBLETHAL LEVELS OF DDT. J. Fish. Res. Bd. Canada, 25(11): 2443-2451.

When underyearling brook trout (Salvelinus fontinalis) were fed DDT at a rate of 2.0 mg/kg per week for 31 weeks, they exhibited greater weight gain (43.2 ± 0.8 g) during the period than did untreated fish (36.6 ± 1.1 g). When underyearling fish were fed DDT at different rates for 26 weeks and then starved or fed at a rate equivalent to 10% of the usual feeding rate, the cumulative mortality during this period was 96.2% among fish exposed to 3.0 mg/kg per week, 88.6% among fish exposed to 2.0 mg/kg per week, and 1.2% among untreated fish. Differences in the length of survival of DDT-exposed fish occurred due to dosage, sex, and type of starvation. The evidence suggests that the mortality of DDT-exposed fish was due to the interaction of DDT residues with a combination of environmental stresses, namely starvation, decreasing water temperature, and possibly the physiological stress associated with the spawning season. (Auth.)

10321. Allen, Richard L., Thomas K. Meekin, Gilbert B. Pauley, and M. Paul Fujiwara (Washington State Dept. of Fisheries, Wenatchee, Wash.). 1968. MORTALITY AMONG CHINOOK SALMON ASSOCIATED WITH THE FUNGUS Dermocystidium. J. Fish. Res. Bd. Canada, 25(11): 2467-2475.

Serious outbreaks of a pernicious disease caused by the fungus Dermocystidium are reported in both adult and juvenile salmon in the Columbia River and its tributaries. The disease evokes a characteristic histopathology and appears to cause death in a large percentage of the infected fish. The disease appears to be most virulent at water temperatures below 60° F. Some prophylactic relief is given by treatment with the organic herbicide, Diquat, at a dilution of 1:500,000 for 1 hour. (Authors)

10322. Tsuyuki, H., E. Roberts, R.H. Lowes, W. Hadaway, and S. J. Westheim (Fish. Res. Bd. of Canada, Vancouver Lab., Vancouver, B.C., Canada). 1968. CONTRIBUTION OF PROTEIN ELECTROPHORESIS TO ROCKFISH (SCORPAENIDAE) SYSTEMATICS. J. Fish. Res. Bd. Canada, 25(11): 2477-2501.

During 1965-67, multiple hemoglobins of 1,905 specimens, comprising 2 species of Sebastolobus and 26 of Sebastes; muscle proteins of 1,677 specimens, comprising 1 species of Scorpaena, 1 of Scorpaenodes, 2 of Sebastolobus, 2 of Sebastes, and 24 of Sebastes; and eye lens proteins of 431 specimens, covering 1 species of Sebastolobus and 19 of Sebastes were examined by starch-gel zone electrophoresis. Scorpaena, Sebastolobus, and Sebastes specimens were collected in the eastern Pacific Ocean (California to Gulf of Alaska), and Sebastes specimens were collected from the western Atlantic Ocean (Newfoundland). Electropherograms were independent of sex and size. Hemoglobin electropherograms were species specific, and where variant, nongenetically linked patterns appeared, evidence suggested existence of additional species, for example, S. diploproa (2), S. reedi (2), and S. aleutianus (3). Genetically linked polymorphism was detected in hemoglobin protein electropherograms of S. crameri and muscle protein electropherograms of S. elongatus. Species specificity broke down with muscle proteins in many species of Sebastes resulting in the separation of the 27 species examined (from this and other studies) into four distinct subgroupings. Generically distinct patterns were prominently

evident in the muscle proteins of Sebastes, Sebastes, Scorpaenodes, and Scorpaena, but not in Sebastes. The order of difference between Sebastes and Sebastes was no more than that inherent in the four subgroupings within the latter genus. Eye lens proteins were genus-specific only. Relative value of the three groups of proteins as diagnostic tools at various levels of organization and as characters in the phylogenetic analyses of scorpenids is discussed. (Authors)

10323. Owens, Eben L., and Gary A. Gebhardt (Nat'l. Council of the Paper Industry for Air and Stream Improvement, Oreg. State Univ., Corvallis, Oreg.). 1968. A RAPID MARKING TECHNIQUE FOR IDENTIFICATION OF INDIVIDUAL FISH. J. Fish. Res. Bd. Canada, 25(11): 2519-2520.

10324. Fillion, D.B. (Dept. of Zoology, Univ. of Alberta, Edmonton, Alberta, Canada). 1967. THE ABUNDANCE AND DISTRIBUTION OF BENTHIC FAUNA OF THREE MOUNTAIN RESERVOIRS ON THE KANANASKIS RIVER IN ALBERTA. J. appl. Ecol., 4(1): 1-11.

Three artificially regulated environments were investigated: Barrier Reservoir, Upper Kananaskis Lake, and Lower Kananaskis Lake. They are in southwestern Alberta on the eastern slope of the Rocky Mountains. The three reservoirs are oligotrophic and do not support a large biomass of invertebrates. All have a benthic fauna which is qualitatively and quantitatively limited, consisting primarily of three groups, chironomid larvae, pisidia, and oligochaetes. A littoral maximum in numerical abundance does not occur; maximum abundance occurs in the vicinity of the drawdown limits. The region containing the largest standing crops in Barrier Reservoir is a portion of the north-south arm not directly subject to water level fluctuations and receiving moderate amounts of allochthonous materials from the Kananaskis River. A marked reduction in density outside this region is evident. The region exposed by drawdown harbors a variety of benthic organisms and by far the most abundant are the chironomid larvae which have been recorded alive in areas exposed for up to 85 days. Twenty-one species of chironomid larvae were found in Barrier Reservoir with a relatively large proportion represented by the tribe Chironomini. While the greatest total number of species was recorded from the 0-10 m zone, the greatest number of individuals throughout the summer months was recorded from below the drawdown limit. Many of the species were found to exhibit wide bathymetric limits, occurring at all depths in the reservoir. (Auth.)

10325. Kleinert, Stanton J., and Paul E. Degurse. 1968. SURVIVAL OF WALL-EYE EGGS AND FRY OF KNOWN DDT RESIDUE LEVELS FROM TEN WISCONSIN WATERS IN 1967. Wisconsin Dept. of Natural Resources Research Report 37. 30 p.

This study demonstrated eggs and fry of walleyes from ten different waters in Wisconsin contained DDT residues. The sum of DDT and its analogs in the egg samples ranged from .067 to 9.380 ppm. The sum of DDT and its analogs in fry samples ranged from .077 to 9.980 ppm. A strong positive correlation was demonstrated between the DDT content of the eggs and the fry. The magnitude of the DDT residues encountered, however, varied between the waters sampled. The presence of DDT in the walleye eggs was not associated with the success of the hatch. Neither was the median life span of the fry associated with the DDT content of the eggs or the fry. The fat content of the fry, however, was positively correlated with the median life span of the fry; the fatter fry lived longer. Within the range of residue levels encountered, these studies failed to show a relationship between the DDT content and survival of walleye eggs and fry. (Auth. summ.)

10326. Cheek, Randall P. (Bur. of Commercial Fisheries Biological Laboratory, Beaufort, N.C.). 1968. THE AMERICAN SHAD. U.S. Fish and Wildlife Service Fishery Leaflet 614. 13 p.

The life history of the American shad (Alosa sapidissima) is described. The economic importance of the commercial and sport fisheries are reviewed, and the status of research and management of this species are summarized. (Auth.)

10327. Chadwick, Harold K. (Calif. Dept. Fish and Game, Stockton, Calif.). 1969. AN EVALUATION OF STRIPED BASS ANGLING REGULATIONS BASED ON AN EQUILIBRIUM YIELD MODEL. Calif. Fish and Game, 55(1): 12-19.

An equilibrium yield-per-recruit model was used to examine the probable consequences of various changes in striped bass mortality rates. This analysis and an evaluation of striped bass mortality rates in Chesapeake Bay led to a conclusion that angling regulations could be varied over a wide range without endangering the population. Selection of regulations within this range must be based largely on social considerations, although the biological analysis demonstrates principles which should be considered in utilizing the population most effectively. (Auth.)

10328. Carlisle, John G., Jr. (Calif. Dept. Fish and Game, Terminal Island, Calif.). 1969. RESULTS OF A SIX-YEAR TRAWL STUDY IN AN AREA OF HEAVY WASTE DISCHARGE: SANTA MONICA BAY, CALIFORNIA. Calif. Fish and Game, 55(1): 26-46. Illus.

A trawl study was conducted in Santa Monica Bay, an area of large-scale waste disposal, during the years 1958-1963. It was hoped that information on the occurrence and distribution of bottomfish in this area would reveal the effects of waste disposal on their populations. In all, 705 bottom tows in 60 to 600 feet of water yielded 112,799 fish of 104 species plus a number of unidentified juvenile rockfish. Five species made up the bulk of the catch. There was a moderately high yield of fish per tow in 1958, an extreme low in 1959, a buildup in 1960, a high in 1961, and a moderate drop in 1962 and 1963. It was impossible to show that fluctuations in abundance, as measured by trawl catches, were the result of waste discharge in the study area, and not due to natural causes. The sport catch for the years 1958 through 1963 in Santa Monica Bay showed only small fluctuations. Artificial reefs in Santa Monica Bay offered evidence that giant kelp was unable to survive in areas affected by the "fallout" of particulate matter from waste discharges, and possibly from turbidity from the same source. (Auth.)

10329. Bottroff, Lawrence, James A. St. Amant, and Wayne Parker (Calif. Dept. Fish and Game, San Diego, Calif.). 1969. ADDITION OF Pyloodictis olivaris TO THE CALIFORNIAN FAUNA. Calif. Fish and Game, 55(1): 90.

Four young-of-the-year flathead catfish, Pyloodictis olivaris, were collected in the-Hilene Canal system in Imperial County, California. This is the first verified record of flathead catfish reproduction in California. The original introduction of these fish was made by the Arizona Game and Fish Department in the Colorado River in March 1962. (Authors)

10330. Lawson, Walter. 1968. SALMON CULTURE CENTRE ON THE MADELEINE. Atlant. Salm. J. No. 4. pp. 6-9.

To assist in the maintenance and improvement of Atlantic salmon runs in the streams of eastern Canada, a dome-shaped circular salmon hatchery was constructed on the Madeleine River in Quebec. Beginning in the spring of 1969 it is hoped that between 100,000 and 150,000 smolt will be released in selected river systems. The success of such hatchery operations on the salmon fishery of Swedish rivers had an influence on the establishment of this Canadian hatchery.

10331. Gillespie, G.J. 1968. ATLANTIC SALMON REARING STATION IN OPERATION AT MACTAQUAC. Atlant. Salm. J. No. 4. pp. 13-16.

The world's largest Atlantic salmon hatchery has started to function at Mactaquac on the St. John River in New Brunswick. Currently some 300,000 salmon are being reared, but the station has a capacity of over 500,000. Development of three power dams on the river could eventually eliminate the natural run of fish which has been estimated at between 10,000 and 20,000 salmon. About 100 spring run, 600 summer run, and 300 fall run salmon are selected for breeding. The other fish taken in the collecting operation are transported by truck for release above the Mactaquac dam to provide fishing and natural reproduction in the upper river. Various crossings of sexes and ages are being made with each lot kept separate. After a few years the more successful of various crossings and proportions of the crossings can be determined, and then the program can become progressively more selective to use the age and sex groupings which give the best results.

10332. Fraser, T.B. 1968. ATLANTIC SALMON IN NORTHERN LATITUDES. Atlant. Salm. J. No. 4. pp. 20-26.

A brief history of the recorded range of the Atlantic salmon in the ocean, the present commercial fishery on recently located ocean feeding grounds, and the urgent need for agreement by the International Commission for the Northwest Atlantic Fisheries to control the high seas fishery.

10333. Atlantic Salmon Journal. 1968. N.T.A. SPELLS HOPE FOR MINE-POLLUTED RIVERS. Atlant. Salm. J. No. 4. pp. 31-32.

Sodium salt of nitrilotriacetic acid (NTA) appears to hold promise of effectiveness against heavy metal pollution. Zinc and copper escaping from the mining operations in northern New Brunswick and Newfoundland rivers has been detrimental to salmon smolt. It also seems to solve the problem of avoidance reactions. Further field trials will be needed before NTA can be considered a feasible solution to mine wastes.

10334. Elliott, J.M. 1967. THE FOOD OF TROUT (Salmo trutta) IN A DART-MOOR STREAM. J. appl. Ecol., 4(1): 59-71.

The food of trout (Salmo trutta) was investigated in relation to the invertebrate drift and the benthos. Using an electrical stunning machine, fish samples were taken from June 1963 to October 1964 in the day and from April to October 1964 at night. Nearly all the common members of the benthos and drift occurred in the trout stomachs, but only the 1+ and 2+ trout contained the larger members of the benthos and drift. The biomass and numbers of most items in the stomachs increased with the size of the trout, and showed no definite pattern when compared on a monthly basis. The principal day foods were nymphs of Baetis spp. for 0+ trout, terrestrial invertebrates and oligochaetes for 1+ trout, and large larvae of Limnephilidae for 2+ trout. It is suggested that this marked difference in the principal foods reduced the competition for food between the fish classes. Most of the animals taken exclusively from the drift were only important as constituents of the diet in summer, and those taken chiefly from the benthos were important in both winter and summer. Some animals were taken from both drift and benthos in large numbers, especially in winter. The fish samples taken at night indicated that the trout were feeding in the early hours of the night during the summer months. It is concluded that the availability of many benthic animals increased at night and that the trout were utilizing this readily available food either as drift or from the tops of stones. (Auth. summ.)

10335. Hobson, Edmund S. (Bur. of Sport Fisheries and Wildlife, Tiburon Marine Lab., Tiburon, Calif.). 1968. PREDATORY BEHAVIOR OF SOME SHORE FISHES IN THE GULF OF CALIFORNIA. Bureau of Sport Fisheries and Wildlife Research Report 73. 92 p.

Predatory behavior in some Gulf of California shore fishes was studied to define certain general activity patterns. Between 1962 and 1965 over 1,200 hours of underwater observations were made at all hours of day and night. Predatory activity in 46 species was observed, and supplemental data were obtained on many others. Digestive-tract contents from 716 specimens were analyzed. Species that form large, relatively inactive schools close to shore during the day feed nocturnally on prey becoming available after dark. Some species feed in the vicinity of the diurnal schooling sites, but most migrate varying distances offshore. Schools of the sort these fishes form during the day generally are incompatible with their nocturnal feeding, and usually are abandoned after dark in favor of loosely spaced aggregations or independent activity. Most larger inshore piscivores are primarily crepuscular predators on the diurnally schooling fishes. Schooling by many prey species reduces the threat of predation. Schooling by some predators facilitates the capture of prey. All the nocturnally active fishes are predators. Feeding habits among the diurnally active fishes are more varied than among those foraging at night. Most of the diurnal piscivores stalk their prey, or rush out from cover. Other predators prey heavily on injured or distressed prey.

10336. Kato, Susumu. 1968. Triakis acutipinna (GALEOIDEA, TRIAKIDAE), A NEW SPECIES OF SHARK FROM ECUADOR. *Copeia*, No. 2. pp. 319-325.

Triakis acutipinna is distinguished from all other species of the genus by the following combination of characters: lower lobe of caudal fin expanded, with a sharply pointed tip; most fins with white tips, all with sharp tips; snout ovate viewed from above; teeth erect or only slightly oblique; teeth spikelike, a few upper teeth with a secondary cusp on each side of the main cusp, but most with only one secondary cusp on the lateral side (the presence of secondary cusps may be a variable character); lower teeth unicuspid. New data are given for several inadequately described species, and relationships among the genera Calliscyllium, Eridacnis, Mustelus, Neotriakis, Rhinotriacis, and Triakis are discussed. (Auth.)

10337. Nelson, Joseph S. 1968. DEEP-WATER NINESPINE STICKLEBACKS, Pungitius pungitius, IN THE MISSISSIPPI DRAINAGE, CROOKED LAKE, INDIANA. *Copeia*, No. 2. pp. 326-334.

A population of Pungitius pungitius was found in 1966 in Crooked Lake, Moble-Whitley counties, Indiana, the southernmost locality for the species in inland North America. This is the first population to be described indigenous to the Mississippi drainage, one of the postulated refugia for the species during Wisconsin glaciation. Morphological comparisons with populations thought to have been derived from a Mississippi refugium agreed in most respects, but Crooked Lake and Lake Michigan populations differed in pelvic girdle shape and caudal peduncle width. The full number of dorsal spines and caudal scutes were first present at 13 and 21 mm standard length, respectively, in Crooked Lake Pungitius. The pelvic spine first appeared at 14 mm. Pungitius was found between five and 30 m by collecting with rotenone, monofilament gillnets, and Plexiglas traps. Young specimens were most common just within, and a few meters below, the rooted aquatic zone while the adults occurred in greatest numbers in deeper water. Fully ripe females were found from June 9 to July 22, 1966, and from April 9 to August 24, 1967. The temperature ranged from 5° to 25° C at the stratum where Pungitius lived in the summer. Most adults were caught in 6°-12° C water, but were able to survive one week in live boxes at surface shore temperatures of 24°-28° C. (Auth.)

10338. Williams, James D. 1968. A NEW SPECIES OF SCULPIN, Cottus pygmaeus, FROM A SPRING IN THE ALABAMA RIVER BASIN. *Copeia*, No. 2. pp. 334-342.

Cottus pygmaeus is described from 244 specimens taken in Coldwater Spring and its immediate affluent run, a tributary to the Coosa River near Anniston, Calhoun County, Alabama. C. pygmaeus is a member of the bairdii species-group but is not particularly close to any known form of Cottus bairdii. The preopercular armature is reduced, consisting of two spines, and the dorsal fins are contiguous. This pygmy species rarely if ever exceeds 38 mm SL and 45 mm total length. (Auth.)

10339. Tsai, Chu-fa. 1968. VARIATION AND DISTRIBUTION OF THE ROCK DARTER, Etheostoma rupestre. *Copeia*, No. 2. pp. 346-353.

The rock darter, Etheostoma rupestre Gilbert and Swain, is endemic to the Mobile River drainage of Alabama, northeastern Mississippi, and northwestern Georgia. It occurs primarily in the area just below the Fall Line where rapid riffles are commonly present. Numbers of scales, vertebrae, and dorsal fin elements, and squamation of the nape and belly vary geographically and reveal that this species has two strongly differentiated races, the Alabama River race and the Tombigbee River race. A small intergrade population was found in the North River, a tributary of the Tombigbee River. Other characteristics (cephalic pores, female genital papilla, pyloric caeca, osteological structures, coloration, dentition, and counts of anal and pectoral fin rays) are constant throughout the range. (Auth.)

10340. Meyer, Fred P. (Bur. of Sport Fisheries and Wildlife, Stuttgart, Ark.). 1967. CHEMICAL CONTROL OF DISEASES IN WARM-WATER PONDS. *American Fishes and U. S. Trout News*, 12(4): 16-20.

10341. Yerger, Ralph W., and Kenneth Relyea. 1968. THE FLAT-HEADED BULLHEADS (PISCES: ICTALURIDAE) OF THE SOUTHEASTERN UNITED STATES, AND A NEW SPECIES OF Ictalurus FROM THE GULF COAST. Copeia, No. 2. pp. 361-384.

For the past 70 years only one species of flathead bullhead, Ictalurus platycephalus (Girard), has been recognized in the southeastern United States. Critical study has revealed the existence of three distinct species. I. platycephalus is re-described; it is confined to the Atlantic coast from Virginia to Georgia. I. brunneus (Jordan) is sympatric over much of the range of I. platycephalus, and also occurs in the St. Johns River of Florida and in the Apalachicola River on the Gulf Coast. It is distinguished from the former species by a shorter anal fin with fewer rays, a higher number of gill rakers, as well as other morphological features and ecological requirements. I. serracanthus is described as a new species from the Gulf Coastal Plain of Florida, Georgia, and Alabama. It is characterized by light-colored round spots, large serrations on the pectoral spines, and a narrow black margin on the pectoral fin membranes. It appears to be more closely related to the white catfish, Ictalurus catus, than to the other flat-headed species, and apparently evolved in the limestone region of northern Florida, an area of endemism. A theory for the origins and dispersal of I. platycephalus and I. brunneus is proposed, based on the confluence of drainage systems during periods of lowered sea level, and on stream captures in the southern Appalachians. (Authors)

10342. Muir, B. S., and J. I. Kendall. 1968. STRUCTURAL MODIFICATIONS IN THE GILLS OF TUNAS AND SOME OTHER OCEANIC FISHES. Copeia, No. 2. pp. 388-398.

An account of the fusion of gill filaments, known to occur in the billfishes and Acanthocybium, is given for several species of Thunnus. It is concluded that this modification has developed in more than one line and therefore may not be a very useful taxonomic character. In addition, the fusion of secondary lamellae between adjacent filaments is described for Katsuwonus, Euthynnus, and Thunnus. It was not found in Scomber, Acanthocybium, nor the billfishes. Consideration of the function of these two modifications leads to the conclusion that they are associated with the large dimensions of the gills and with the common habit of fast continuous swimming involving passive or "ram" ventilation. (Authors)

10343. Patten, Benjamin G. (Bur. of Commercial Fisheries Biological Laboratory, Seattle, Wash.). 1968. ABNORMAL FRESHWATER FISHES IN WASHINGTON STREAMS. Copeia, No. 2. pp. 399-401.

10344. Lagios, Michael D. (Dept. of Pathology, Univ. of California, San Francisco, Calif.). 1968. THE PITUITARY GLAND OF THE PADDLEFISH, Polyodon spathula. Copeia, No. 2. pp. 401-404.

10345. Herald, Earl S. (Steinhart Aquarium, California Academy of Sciences, San Francisco, Calif.). 1968. SIZE AND AGGRESSIVENESS OF THE SEVENGILL SHARK (Notorynchus maculatus). Copeia, No. 2. pp. 412-414.

10346. Fraser, Thomas H. 1968. COMPARATIVE OSTEOLOGY OF THE ATLANTIC SNOOKS (PISCES, Centropomus). Copeia, No. 3. pp. 433-460.

The osteology of Centropomus poeyi is described in detail. Four other species, C. undecimalis, C. pectinatus, C. parallelus, and C. ensiferus are compared osteologically with C. poeyi. These five species occur in the western Atlantic and C. pectinatus also occurs in the eastern Pacific. Hyperossification of certain bones in C. parallelus is described for the first time and is thought to be species specific. C. pectinatus is the most specialized of the five species studied in detail; it is probably the most specialized of the genus. General differences in the osteology of the five western Atlantic species are discussed. A generic diagnosis is given. Relationships within the genus are suggested, based on the osteology of the five western Atlantic species and three (C. unionensis, C. armatus, and C. robalito) of the four exclusively eastern Pacific species and on the external morphology of the nine established species. (Auth.)

10347. Smith, Allen J., John H. Howell, and George W. Piavis. 1968. COMPARATIVE EMBRYOLOGY OF FIVE SPECIES OF LAMPREYS OF THE UPPER GREAT LAKES. *Copeia*, No. 3. pp. 461-469.

The four species of lampreys native to the upper Great Lakes (American brook lamprey, Lampetra lamotteni; chestnut lamprey, Ichthyomyzon castaneus; northern brook lamprey, I. fossor; and silver lamprey, I. unicuspis) were collected in various stages of their life cycle and maintained in the laboratory until sexually mature. Secondary sex characters of the four native species are compared. Several batches of eggs of each species were reared at 18.4° C and their development was compared to that of the exotic sea lamprey, Petromyzon marinus. The temperature of 18.4° C was previously determined to be optimum for development of the sea lamprey. The high percentage survival of many batches of eggs of native species to prolarvae indicated that 18.4° C was near the optimum for them. Survival to the burrowing stage varied considerably among different batches of eggs from the same species; some batches failed to produce prolarvae. The staging characteristics used for the sea lamprey were applicable to the native species, except for the end point of the burrowing stage. Embryos of the native species in each stage of development appeared according to the time sequence established for the sea lamprey. (Authors)

10348. Bartlett, Martin R., and Richard L. Haedrich. 1968. NEUSTON NETS AND SOUTH ATLANTIC LARVAL BLUE MARLIN (Makaira nigricans). *Copeia*, No. 3, pp. 469-474.

Neuston nets to sample the fishes that congregate at the sea surface have been developed at the Woods Hole Oceanographic Institution, and the characteristics of three successful designs—for use at cruising speed (9 knots) and trawling speed (6 knots)—are presented. On a cruise from 8° S to 36° S off the coast of South America, neuston nets were used at trawling speed and drifting. Eighty-five larval Makaira nigricans Lacépède were taken on the first half of the cruise (8°-25° S), when surface temperatures were around 28° C; no marlin were taken on the second half, when temperatures had fallen below 25° C. (Authors)

10349. Zorach, Timothy. 1968. Etheostoma bellum, A NEW DARTER OF THE SUBGENUS Nothonotus FROM THE GREEN RIVER SYSTEM, KENTUCKY AND TENNESSEE. *Copeia*, No. 3. pp. 474-482.

Etheostoma bellum is described from 543 specimens from the Green River System in Kentucky and Tennessee. It is clearly related to E. rufileineatum and E. camurum which occur in adjacent river systems, but is distinguished from them primarily on the basis of color pattern. It occurs sympatrically with E. m. maculatum and E. tippecanoe of the subgenus Nothonotus. In coloration, the males of E. bellum approach E. rufileineatum while the females resemble the females of E. camurum most closely. (Auth.)

10350. Saunders, Dorothy Chapman. 1968. DIFFERENTIAL BLOOD CELL COUNTS OF 50 SPECIES OF FISHES FROM THE RED SEA. *Copeia*, No. 3. pp. 491-498.

Differential blood cell counts were made of heart blood smears of 222 fishes from the Red Sea, belonging to 50 species of 19 families. The first 100 red corpuscles seen on each slide were counted and listed as either erythroblasts or erythrocytes. Mature erythrocytes were measured in each species of fish, and their mean values in microns calculated for length and width. The first 100 leukocytes seen on each slide were also counted, and listed under the following categories: 1. elasmobranch; hemocytoblasts, monocytes, lymphocytes, thrombocytes, and any of three types of granulocytes (eosinophils, heterophils, neutrophils); 2. teleost; hemoblasts, macrophages, lymphocytes, thrombocytes, and any of three types of granulocytes (eosinophils, basophils, neutrophils). The mean percentage of each type of leukocyte present was calculated for each fish species. Eosinophils were seen in the one elasmobranch species, and in six species of the teleosts. No basophils were found. (Auth.)

10351. Weisel, George F. (Zoology Dept., Univ. of Montana, Missoula, Mont.). 1968. THE SALMONOID ADIPOSE FIN. *Copeia*, No. 3. pp. 626-627.

10352. Lyman, Charles P. (Dept. of Anatomy, Harvard Medical School, Boston, Mass., and Museum of Comparative Zoology, Harvard Univ., Cambridge, Mass.). 1968. BODY TEMPERATURE OF EXHAUSTED SALMON. *Copeia*, No. 3. pp. 631-633.

10353. Carlton, William G., and William B. Jackson (Dept. of Biology, Bowling Green State Univ., Bowling Green, Ohio). 1968. THE EYE LENS AS AN AGE INDICATOR IN CARP. *Copeia*, No. 3. pp. 633-636.

10354. Frost, Winifred E., and Charlotte Kipling (Freshwater Biological Assoc., The Ferry House, Ambleside, Westmorland, England). 1967. A STUDY OF REPRODUCTION, EARLY LIFE, WEIGHT-LENGTH RELATIONSHIP AND GROWTH OF PIKE, *Esox lucius* L., IN WINDERMERE. *J. Anim. Ecol.*, 36(3): 651-693.

Pike were sampled by means of gill nets in winter from 1944 to 1965. The majority of both male and female pike breed for the first time at age 2 years; the mean length of the males is then 38 cm and of the females 42 cm. The ovaries build up from October to March and when ripe form 18-20% of the body weight. The unfertilized ovum is 2.3 mm in diameter. The building up of the testis is completed by October and when ripe it forms only 2-4% of the body weight. As the fish increases in weight the number of eggs increases in proportion. The pike produces about 27 eggs per gram of total body weight, but there is marked individual variation. In Windermere the breeding season lasts from mid-March to the beginning of May with mid-April as the height of the spawning time. The surface water temperature is then about 6-8° C. Spawning grounds have silty substrates with some stones, the vegetation consists mainly of *Elodea*, *Myriophyllum* and *Nitella*; it is on these submerged aquatic plants that the eggs are found. There is evidence of "homing" in the sense of the fish repeatedly returning to spawn in a particular place. Eggs incubated in the laboratory took a minimum of 14 days and a maximum of 21 days to hatch at water temperatures ranging from 6.6° to 12.5° C; eggs reared at 10° C hatched in 12 days. For the first few days of life the alevins were attached to vegetation. This has the advantage of keeping them clear of silt, hiding them from predators and providing access to the Entomostraca on which they feed. Observations of pike fry in aquaria during their first four months of life showed that they had a home range (not a territory), were aggressive only if crowded, had the same technique of feeding as adults, and moved little. The selective action of 2-1/2 in. (6.4 cm) bar gill net did not invalidate the use of data from gill netted pike for the calculation of age, growth and weight-length equations. The parameters of the weight-length equation $W = AL^b$ for pike caught in the summer were as follows: immature $A = -2.28$, $b = 3.0$; mature males $A = -2.44$, $b = 3.18$; mature females $A = -2.59$, $b = 3.27$. All b s differed significantly from 3. Age and growth were calculated from the opercular bones of about 7,000 pike and confirmation of the accuracy of the calculations was obtained from recaptured tagged fish. Females grew faster than males after the first year of life. No significant difference in growth was found between pike caught in the north and south basins of the lake. In 1944-45 pike aged 8 years and over formed about 20% of the catch but only 2% of the catch after 1950. The oldest were aged 17 years; the majority were aged 4 or 5 years. Growth was well described by the von Bertalanffy equation with $t_0 = W_0 = 0$. For the year-classes 1951-55 males $L_\infty = 77$ cm, $K = 0.36$; for females $L_\infty = 99$ cm, $K = 0.28$. Wide variations in growth were apparent between different year-classes, and between individual pike of the same year-class. Growth was better in years when the temperature was high. Temperature accounted for 86% of the variation between year-classes in the weight of females aged 4 years. Length increments of males and females in the fourth year of life and specific growth rates of females in the third year of life were also positively correlated with temperature. Pike of the year-classes 1930-38, which lived in the lake before any pike were removed by gill netting, grew more slowly than the year-classes 1951-55. The mean lengths of females at 4 years were (1930-38) 61 cm and (1951-55) 67 cm and of males (1930-38) 54 cm and (1951-55) 59 cm. (Authors summ.)

10355. Mayhew, James. 1967. COMPARATIVE GROWTH OF FOUR SPECIES OF FISH IN THREE DIFFERENT TYPES OF IOWA ARTIFICIAL LAKES. *Proc. Iowa Acad. Sci. for 1965*. Vol. 72, pp. 224-229.

Growth of largemouth bass, bluegill, black crappie, and white crappie are compared in three different types of Iowa artificial lakes and reservoirs. The lakes were classified by similarity of physical, chemical, and biological characteristics. Scale samples and total length measurements were obtained from 14,705 fish at 71 impoundments. Factors influencing differences in growth rate in the three types of impoundments are discussed. (Auth.)

10356. Welker, Bill D. 1967. FISH POPULATION IN FIVE MISSOURI RIVER OX-BOW LAKES. *Proc. Iowa Acad. Sci. for 1965*. Vol. 72, pp. 230-237.

Fish populations in five Missouri River ox-bow lakes were investigated during 1963 and 1964. This was a joint project of the Iowa Conservation Commission; Nebraska Game, Forestation and Parks Commission, and the United States Fish and Wildlife Service. Gizzard shad were the most abundant fish. Shad, freshwater drum, and carp sucker composed over 60% of all fish caught in four lakes. Crappie were the most numerous game fish comprising between 29% and 81% of the game fish caught in the various ox-bows. Channel catfish, white bass and bluegill were abundant in most lakes. Indigenous populations including northern pike, sauger, walleye, largemouth bass, yellow perch, flathead catfish, paddlefish, bullheads, orangespotted sunfish and green sunfish were also present. (Auth.)

10357. Bachmann, Roger W. 1967. SOME CHEMICAL CHARACTERISTICS OF IOWA LAKES AND RESERVOIRS. *Proc. Iowa Acad. Sci. for 1965*. Vol. 72, pp. 238-243.

Chemical analyses were made of the surface waters of 61 Iowa lakes and reservoirs during the summer of 1964. With the exception of one bog lake, they all had typical hard waters of the bicarbonate type. Their average composition was similar to the 10-year average compositions of the Iowa and Cedar rivers. There was a tendency for the lakes lying within the Wisconsin glacial drift sheet to have higher values for all parameters measured, although the differences were not considered biologically significant. (Auth.)

10358. McDonald, Donald B., and Robert D. Schmickle. 1967. FACTORS AFFECTING WINTER FISH KILLS IN THE CORALVILLE RESERVOIR, IOWA. *Proc. Iowa Acad. Sci. for 1965*. Vol. 72, pp. 243-247.

The Coralville Reservoir, located on the Iowa River just upstream from Iowa City, has as its primary purpose the control of floods on the rivers downstream. A conservation pool is maintained for recreational purposes. During December 1964 and January 1965, a combination of rather unusual circumstances caused an almost complete depletion of oxygen in the reservoir and resulted in a fish kill. Oxygen demand of the incoming water from a sudden winter rain greatly exceeded the available oxygen dissolved in the lake. A heavy ice cover prevented the renewal of oxygen by wind action. The depletion continued until warm rains, melting snow, warmer weather, and the partial drainage of the lake to provide for the flood storage level resulted in the complete replacement of the contents. (Authors)

10359. Schoumacker, Roger, and Gary Ackerman. 1967. COMPARATIVE AGE AND GROWTH OF CHANNEL CATFISH FROM SOME EASTERN IOWA RIVERS. *Proc. Iowa Acad. Sci. for 1965*. Vol. 72, pp. 248-253.

During 1963 and 1964, catfish populations were sampled in various rivers in eastern Iowa, and 1,391 spines were collected and analyzed for age. Growth rates varied considerably, with fish from the Wapsipinicon River at Anamosa being the slowest growing, followed by fish from the Wapsipinicon River at Independence, the Cedar River at Gilbertville and Cedar Rapids, and the Iowa River at Marshalltown. Faster growth was exhibited by fish from two renovated areas—the Iowa River in the Iowa Falls-Steamboat Rock area and Fontana Mill Lake—from the lower 8 miles of the Skunk River, and from various pools in the Mississippi River. It is suggested that the removal of a portion of the catfish population in selected areas, perhaps in conjunction with a rough fish removal program, would stimulate catfish growth. (Authors)

10360. Behmer, David J. 1967. SPAWNING PERIODICITY OF THE RIVER CARPSUCKER, Carpoides carpio. Proc. Iowa Acad. Sci. for 1965. Vol. 72, pp. 253-262.

The sex ratio of river carpsuckers collected from the Des Moines River differed significantly from 1:1, females being most abundant. Spawning had already begun in early June and some fish were found ripe as late as August. No carpsuckers younger than age IV were found mature. All ripening carpsucker ovaries contained a group of eggs that seemed to be degenerating. It is not certain if carpsuckers spawn more than once in a season. (Auth.)

10361. Kudrna, Joel J. 1967. MOVEMENT AND HOMING OF SUNFISHES IN CLEAR LAKE. Proc. Iowa Acad. Sci. for 1965. Vol. 72, pp. 263-271.

During the summer of 1964, pumpkinseeds (Lepomis gibbosus), bluegills (Lepomis macrochirus) and green sunfish (Lepomis cyanellus) were taken by shocking in certain areas of Clear Lake, Iowa, marked with numbered jaw tags, and displaced to other neighboring areas. Recaptures indicate that separate populations live in various parts of the lake. Recapture rates for pumpkinseeds and bluegills replaced in their home areas were higher than for those displaced to other areas. No correlation was shown between homing and distance displaced, but distances did not exceed 2,200 feet. The larger fish showed a greater homing tendency. Home ranges are apparently maintained only for relatively short periods by these fish. Direct observation of homing indicated that green sunfish have a higher precision in orienting themselves and returning to the area of original capture than do the other two species. (Auth.)

10362. Nelson-Smith, Anthony. 1968. THE EFFECTS OF OIL POLLUTION AND EMULSIFIER CLEANSING ON SHORE LIFE IN SOUTH-WEST BRITAIN. J. appl. Ecol., 5(1): 97-107.

In considering the effects of oil pollution on British shores, it is also necessary to consider the effect of the emulsifier cleansing which in recent years has inevitably followed it. The reported toxicities of crude oil, emulsifiers and their active constituents are briefly reviewed. Of three major oil-spills in Milford Haven, one in 1962 provided evidence of a marked increase in algal cover following heavy limpet mortalities. The most recent, in January 1967, polluted shores on which the distribution and abundance of common plants and animals was well known, so that the immediate effects could be accurately determined. Effects similar in nature but greater in extent were recorded in Cornwall following the wreck of the "Torrey Canyon" in March 1967. Many of the mechanisms which protect shore animals from natural environmental extremes are ineffective against stranded oil, whilst emulsifiers tend to make it an even greater biological danger. (Auth. summ.)

10363. Moore, W.H. 1968. A LIGHT-WEIGHT PULSED D.C. FISH SHOCKER. J. appl. Ecol., 5(1): 205-208.

A light-weight pulsed D.C. fish shocker capable of working in freshwater with conductivities ranging from 60 μ mhos (very soft water) to 500 μ mhos (very hard water) is described, and general field results are given. (Auth. summ.)

10364. DeVaney, Thomas E. (Bur. of Sport Fisheries and Wildlife, Div. of Pesticide Registration, Washington, D.C.). 1968. CHEMICAL VEGETATION CONTROL MANUAL FOR FISH AND WILDLIFE MANAGEMENT PROGRAMS. Bureau of Sport Fisheries and Wildlife Resource Publication 48. 42 p.

The manual has been prepared as a guide for vegetation control operations of the Bureau of Sport Fisheries and Wildlife and for programs approved by the Bureau for Federal reimbursement. It is intended also to provide the management biologist with information about the chemical, physical, and biological properties of some herbicides currently available. The manual will be revised from time to time to include additional information from management reports and research.

10365. Clifford, Hugh F. (Dept. of Zoology, Univ. of Alberta, Edmonton, Alberta, Canada). 1966. SOME LIMNOLOGICAL CHARACTERISTICS OF SIX OZARK STREAMS. Missouri Dept. Conservation, Div. Fisheries, D-J Series No. 4. 55 p.

Physical, chemical and biological conditions were studied in six Ozark streams, Current, Jacks Fork, Gasconade and Big Piney Rivers and Huzzah and Courtois Creeks. Water chemistry characteristics of various streams illustrated the degree of influence due to geochemical and human activity factors. Biologically, the streams exhibited distinct floral and faunal characteristics normally associated with unpolluted waters. Statistical comparisons of certain chemical and biological parameters were made between stations. From these it was possible to demonstrate the degree of chemical and aquatic invertebrate differences in stations, rivers and drainage areas. All streams were located in the relatively remote Ozarks area and received very little domestic or industrial wastes. The predominant bedrock of the area was limestone; stream bed gravel was composed chiefly of chert fragments. The region is characterized by numerous large springs, and these influenced the water chemistry of the streams. All streams were well buffered; pH values ranged from 7.2 - 8.2 and exhibited very slight daily changes. Specific conductance ranged from 139 to 418 micromhos. A daily oxygen rhythm was noticeable even at the well-aerated upstream stations. Current River, Jacks Fork and Huzzah and Courtois Creeks were exceedingly clear (1 - 10 ppm) and exhibited very low phosphorous concentrations (0.000 - 0.016 ppm). Gasconade and Big Piney Rivers were less clear (3 - 34 ppm) and had relatively higher concentrations of inorganic phosphorous (0.002 - 0.180 ppm). Consistently larger concentrations of nitrates (0.08 - 0.36 ppm) in Current River apparently were supplied from the large springs. A definite downstream decline in dissolved silica was noted in all streams. Algae consisted almost entirely of diatoms. Community types were similar at upstream stations of all rivers. Different community types occurred at downstream stations of Current and Gasconade Rivers. Greatest densities of diatoms were noted in Current River. Presence of diatoms in the water from Montauk Springs suggested that part of the flow originated in a permanent body of surface water. Mayflies were the chief component of the bottom fauna. All stations exhibited distinct faunal characteristics normally associated with unpolluted waters. Statistical comparisons of similarity between stations showed least variation between drainage areas. Samples of invertebrates from springs exhibited a high degree of similarity, the fauna being characterized by few species and large numbers of certain groups.—John L. Funk

10366. Funk, John L. (Missouri Dept. of Conservation, Columbia, Mo.). 1968. MISSOURI'S FISHING STREAMS. Missouri Dept. Conservation, Div. Fisheries, D-J Series No. 5. 108 p.

The warmwater streams of Missouri provide an important part of the fishery of the state, so this list of Missouri's streams capable of supporting fish is of value for fisheries management purposes. Streams are listed by watershed in natural order progressing upstream. Name, location (county) of headwater and mouth, drainage area (square miles), length (miles) of permanent flow and of intermittent portion which maintains permanent pools are given. Listed are 2,300 streams, including 703 unnamed laterals. A total of 9,865 miles of streams maintain permanent flow and 8,218 miles of intermittent streams maintain permanent pools, and thus will support fish. A summarizing table listing the major watersheds and an alphabetical index of streams with 10 miles or more of permanent flow are included. (Auth.)

10367. Sarig, S. 1968. BIBLIOGRAPHY ON FISHPONDS AND INLAND WATERS IN ISRAEL. *Bamidgeh*, 20(2): 39 p.

10368. Thomas, Bill. 1968. FISH THE COAL HOLES. *Field and Stream*, 74(7): 168-171, 173, 175-177.

Although many of the strip-mine lakes are so acid that only carp and bullheads can live in them, others provide good fishing. There is a good possibility that some of the less acid lakes can be managed for better fishing.

10369. Scheffer, Paul M. (U.S. Dept. of Agriculture, Soil Conservation Service, 701 Northwest Glisan, Portland, Oregon). 1968. TROUT FARMING. U.S. Dept. of Agriculture, Soil Conservation Service, Portland, Oreg. 10 p.

A leaflet particularly designed for prospective trout farmers who need assistance in evaluating their soil, water, and market resources for this type of enterprise.

10370. Orsi, James J. (Calif. Dept. Fish and Game, Stockton, Calif.). 1968. THE EMBRYOLOGY OF THE ENGLISH SOLE, Parophrys vetulus. Calif. Fish and Game, 54(3): 133-155. Illus.

Mature fish were artificially spawned and the eggs incubated at $10.6^{\circ}\text{C} \pm 0.4^{\circ}\text{C}$, and the larvae were raised in 2-liter beakers or quart jars at the same temperature. Egg samples were preserved and sectioned to study changes not visible in living material. Photomicrographs were taken. The unfertilized eggs average 0.98 mm in diameter. They are transparent and spherical, lacking oil globules and pigment. They have numerous small oil droplets and the surface of the egg membrane is pierced by many small pores and is thrown into fine ridges. Fertilized eggs average 0.99 mm in diameter. They have a very small perivitelline space, a thickened fertilization membrane, and float with the animal pole down. Early cleavages conform to the typical teleost pattern. They begin 2 hours after fertilization and continue at 1-hour intervals. No segmentation cavity exists because the periblast adheres to the lower surface of the blastomeres. Gastrulation begins at 25 hours and produces a large subgerminal cavity. Blastopore closure is at 48-49 hours, when the eye vesicles, olfactory sacs, neural cord, notochord, Kupffer's vesicle, and 11 somites have formed. An unusual caudal vesicle arises at this time and becomes located behind Kupffer's vesicle. Its history and significance in P. vetulus is discussed. Hatching begins at 98 hours and continues for 10 hours more. Newly hatched larvae are 2.85 mm TL, have unpigmented eyes, and float with the yolk sac up. Eye pigmentation is completed between 6 and 9 days. The yolk sac is absorbed at 9 or 10 days, and an average length of 4.6 mm is reached between 9 and 12 days. In the absence of food, the last surviving larvae die at 14 days. (Auth.)

10371. Engen, Paul C. (Calif. State College at Fullerton, Fullerton, Calif.). 1968. ORGANOGENESIS IN THE WALLEYE SURFPERCH, Hyperprosopon argenteum (Gibbons). Calif. Fish and Game, 54(3): 156-169. Illus.

Major variations in the development of this species occur in the digestive and cardiovascular systems. These unusual features are probably characteristic of all members of the family Embiotocidae. Modifications in the digestive system include the early opening of the first gill cleft, the development of tall columnar epithelium with associated flagellar-like structures in the esophageal region, and a tremendous enlargement of the hindgut containing many long villi. The heart develops from a solid cell mass just anterior to the yolk. Early in development, the sinus venosus envelops the yolk except dorsally where it lies adjacent to the liver. This places the yolk in direct contact with the blood circulating through the heart. With the formation of the septum separating the pericardial and peritoneal cavities, the yolk becomes associated with the liver and lies next to the hepatic vein. It continues to remain closely allied with the hepatic vein until the yolk substance is completely absorbed. (Auth.)

10372. Duffy, J.M. (Calif. Dept. Fish and Game, Terminal Island, Calif.). 1968. JACK MACKEREL YIELD PER AREA FROM CALIFORNIA WATERS, 1955-56 THROUGH 1963-64. Calif. Fish and Game, 54(3): 195-202. Illus.

The commercial catch of jack mackerel, Trachurus symmetricus, ranged from 11,352 to 54,707 tons per season during the period 1955-56 through 1963-64. Southern California waters were the most productive, accounting for 90% of the total catch in all but three seasons. During the first three seasons, catches totaled 97,764 tons, with 72% taken from inshore areas off southern California. The next three-season group produced only 69,968 tons. Less than 38% of this was from southern California inshore waters, while the offshore waters contributed

45%. The last three seasons produced 145,167 tons, with 32% taken in the off-shore regions of southern California. This shift in catch localities seems to be caused partly by a decline in the sardine fishery. Other possible factors have not been analyzed to date. (Author)

10373. Hosie, Michael J., and Carl E. Bond (Dept. Fisheries and Wildlife, Oregon State Univ., Corvallis, Oreg.). 1968. NORTHERN RANGE EXTENSION FOR THE KELP BASS, Paralabrax clathratus (Girard). Calif. Fish and Game. 54(3): 216-217.

The known range of P. clathratus has been extended some 345 miles northward. A male P. clathratus was captured September 11, 1965, approximately 1 mile south of the entrance of the Columbia River (46° 14' N lat., 124° 06' W long.) by a fisherman on the sport fishing boat Dreamer operating out of Warrenton, Oregon. Scales of the specimen showed six annuli, indicating a growth rate comparable to that of kelp bass from southern California. (Authors)

10374. Grant, P. T., and K. B. M. Reid. 1968. BIOSYNTHESIS OF AN INSULIN PRECURSOR BY ISLET TISSUE OF COD (Gadus callarias). Biochem. J., 110(2): 281-288.

At 15°, slices of cod islet tissue incorporated [^{14} C] proline into proteins soluble in acid-ethanol at a linear rate for 6 hours. Initially, all the radioactivity was associated with a polypeptide that had a molecular weight of about 10,000 and was appreciably more basic than cod insulin. After 1 hour there was also a significant and progressive increase in the radioactivity of insulin and of fractions intermediate in molecular size and basicity between the polypeptide and insulin. O-Ethyl O-p-nitrophenyl phenylpropylphosphonate markedly decreased the radioactivity both of the intermediate fractions and of insulin, but had no significant effect on the biosynthesis of the polypeptide. In contrast, puromycin inhibited the incorporation of radioactivity into all the fractions. The polypeptide had an activity of less than 0.2 international unit/mg. in the epididymal-fat-pad bioassay. Treatment with low concentrations of trypsin caused a progressive increase in the formation of an insulin-like material, judged by bioassay and ion-exchange chromatography of the digest. Gel filtration of the polypeptide after oxidative sulfitolysis indicated that it was a single polypeptide chain. The results suggest that the polypeptide is an insulin precursor whose formation is inhibited by puromycin and that the steps involved in the conversion of precursor into product are sensitive to O-ethyl O-p-nitrophenyl phenylpropylphosphonate. (Authors)

10375. Reid, K. B. M., P. T. Grant, and A. Youngson. 1968. THE SEQUENCE OF AMINO ACIDS IN INSULIN ISOLATED FROM ISLET TISSUE OF THE COD (Gadus callarias). Biochem. J., 110(2): 289-296.

S-Aminoethylcysteinyl derivatives of the A and B chains of cod insulin were prepared from the individual S-sulpho chains. Studies on small peptides derived from the S-aminoethylated peptide chains by treatment with trypsin allowed the amino acid sequences in the region of the cysteinyl residues of the A and B peptide chains to be defined. The six amide groups in cod insulin were located by complete digestion of small peptides from the A and B chains with aminopeptidase followed by amino acid analyses. The results, together with previous studies on the oxidized A and B chains, define the sequences of the 51 amino acids that constitute cod insulin. (Authors)

10376. Somero, G. N., and P. W. Hochachka. 1968. THE EFFECT OF TEMPERATURE ON CATALYTIC AND REGULATORY FUNCTIONS OF PYRUVATE KINASES OF THE RAINBOW TROUT AND THE ANTARCTIC FISH Trematomus bernacchii. Biochem. J., 110(3): 395-400.

The effects of temperature on the catalytic and regulatory properties of pyruvate kinases from the temperate-zone rainbow trout and the Antarctic fish Trematomus bernacchii were examined. The K_m value of pyruvate kinase for one of its two substrates, phosphoenolpyruvate, is temperature-dependent, and is lowest at temperatures that closely coincide with the habitat temperatures of the

two fishes. Two regulatory functions of pyruvate kinase, feed forward activation by fructose diphosphate and feedback inhibition by ATP, are temperature-independent. Enzyme-ADP interaction is also temperature-independent. It is concluded that enzyme-substrate and enzyme-modulator interactions are important factors in short-term and in evolutionary adaptations by poikilotherms to changes in temperature. Though the K_m for substrate may vary in apparently adaptive manners, the regulatory functions of an enzyme appear to be unchanged over the range of temperatures experienced by the organism in nature. (Authors)

10377. Lush, I.E., and C.B. Cowey. 1968. GENETIC VARIATION OF COD AND COALFISH LACTATE DEHYDROGENASE. *Biochem. J.*, 110(3): 33p-34p.

10378. Chadwick, Harold K. (Calif. Dept. Fish and Game, Stockton, Calif.). 1968. MORTALITY RATES IN THE CALIFORNIA STRIPED BASS POPULATION. *Calif. Fish and Game*, 54(4): 228-246. Illus.

Mortality rates for the Sacramento-San Joaquin River system striped bass (*Roccus saxatilis*) population were calculated from tag returns. Annual variations and variations among different parts of the population were examined. (Auth.)

10379. Edwards, Stephen R., and Fuad M. Nahhas (Dept. Biological Sciences, Univ. of the Pacific, Stockton, Calif.). 1968. SOME ENDOPARASITES OF FISHES FROM THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA. *Calif. Fish and Game*, 54(4): 247-256. Illus.

A survey of 236 fishes representing 26 species in fresh waters of the Sacramento-San Joaquin Delta revealed the presence of a number of helminths. The present paper discusses or describes the following species. Trematoda: *Posthodiplostomum minimum centrarchi* (MacCallum, 1921; Dubois, 1936) Hoffman, 1958 from *Archoplites interruptus* (Girard), *Chaenobryttus gulosus* Cuvier, *Lepomis cyanellus* Rafinesque, and *L. macrochirus* Rafinesque; *Neascus* sp. from *Hysterocarpus traskii*; *Neascus* sp. from *Lepomis cyanellus*; *Pisciamphistoma stunkardi* (Holl, 1929) Yamaguti, 1934 from *Chaenobryttus gulosus* and *Lepomis gibbosus* Linnaeus; *Alloglossidium corti* (Lamont, 1921) Mueller, 1930 from *Ictalurus catus* (Linnaeus) and *Lepocreadium californianum* sp. n. from *Roccus saxatilis* (Walbaum). Cestoda: *Corallobothrium giganteum* Essex, 1927 from *Ictalurus catus*; *C. fimbriatum* Essex, 1927 from *Ictalurus catus*; *Bothriocephalus* sp. from *Chaenobryttus gulosus* and *Lepomis cyanellus*; *Pelichnibothrium* sp. from *Salmo gairdnerii* Richardson. Acanthocephala: *Rhadinorhynchus* sp. from *Salmo gairdnerii*. A key to 23 species in the genus *Lepocreadium* is given. (Authors)

10380. MacGregor, John S. (Bur. of Commercial Fisheries, Fishery-Oceanogr. Center, La Jolla, Calif.). 1968. FECUNDITY OF THE NORTHERN ANCHOVY, *Engraulis mordax* Girard. *Calif. Fish and Game*, 54(4): 281-288.

The ovaries and ovarian eggs of the northern anchovy are described briefly and compared with those of two other engraulids, *Cetengraulis mysticetus* and *Anchoa naso*. The number of eggs spawned in one batch of *E. mordax* was estimated to be 574 per g of total weight of the female compared with 836 for *C. mysticetus* and 326 for *A. naso*. Other factors used to determine biomass of adult male anchovies from planktonic egg census data are discussed. The biomass of adult male anchovies in the commercial catch was about 75% of that of adult females. Therefore, for one spawning, 5.2×10^8 eggs would be produced per short ton of female anchovy or 3.0×10^8 eggs per short ton of adult biomass. The average number of times each female anchovy spawns in a year is not known and may vary from year to year. (Auth.)

10381. Duffy, John M. (Calif. Dept. Fish and Game, Terminal Island, Calif.). 1968. DEFORMED LATERAL LINE IN A JACK MACKEREL, *Trachurus symmetricus* (Ayres). *Calif. Fish and Game*, 54(4): 306. Illus.

A 167 mm FL jack mackerel, taken April 13, 1967, in a purse seine off San Clemente Island, had a deformed lateral line on its right side. The lateral line was broken into two separate segments. The posterior portion appeared normal; however, the anterior portion was recurved and separated from the posterior portion by a distance of 8 mm. (Auth.)

10382. Miller, Lee W., and Robert J. McKechnie (Calif. Dept. Fish and Game, Sacramento, Calif.). 1968. OBSERVATION OF STRIPED BASS SPAWNING IN THE SACRAMENTO RIVER. Calif. Fish and Game, 54(4): 306-307.

On June 9, 1967, an aggregation of several thousand striped bass was observed at Steiner Road on the Sacramento River. Fish in this aggregation were concentrated in a long, narrow band close to the river bank and appeared to be resting and inactive. Spawning activities or "rock fights" were observed in the stronger midstream currents. The water temperature was 62° F. (Authors)

10383. Deyoe, C. W., O. W. Tiemeier, and C. Suppes (Kansas State Univ., Manhattan, Kansas). 1968. EFFECTS OF PROTEIN, AMINO ACID LEVELS AND FEEDING METHODS ON GROWTH OF FINGERLING CHANNEL CATFISH. Progr. Fish Cult., 30(4): 187-195.

Studies were made to determine the effects of protein levels, vitamin additions, added amino acids, and different feeding systems on channel catfish, Ictalurus punctatus, fingerlings. Survival on all diets averaged 94.9%. Differences in survival, gain per fish, and feed conversion among treatments were not significant. Average gain per fish and gain per pond were improved with diets containing 25% protein. Differences in total gain per pond were significant between fish receiving 25% protein and 22% protein. Differences between additional riboflavin, niacin, pantothenic acid, choline chloride, and vitamin B₁₂ were not significant. Trends in gain per fish, gain per pond, and feed conversion were slightly in favor of diets with added vitamins. Diets containing additional lysine and methionine were not superior to diets without the additional amounts of amino acids. Fish receiving 1/2 of their feed in the morning and 1/2 in the afternoon appeared to be more efficient than fish receiving entire ration in 1 feeding. Reduction of feed rate to 3/4 of the amount of feed as the control ration resulted in reduced responses to the feeding. (Authors)

10384. Olson, Donald E. (Minnesota Div. of Fisheries, Detroit Lakes, Minn.). 1968. SEX RATIOS OF YOUNG-OF-YEAR WALLEYES IN MINNESOTA REARING PONDS AND LAKES. Progr. Fish Cult., 30(4): 196-202.

Young-of-year walleyes (Stizostedion v. vitreum) raised in Minnesota rearing ponds showed a statistically significant preponderance of males in 19 of 36 collections taken over a 3-year period, the percentage of males ranging from 58.1 to 95.0. The remaining 17 collections did not vary from a 50:50 sex ratio at the 5% level of significance, the percentage of males ranging from 40.4 to 57.9. For all pond collections, the average percentage of males was 61.2. In contrast, in seven collections from the natural walleye lakes sex ratios had nearly even or a slight, but significant, preponderance of females. The average proportion of males in all lake samples was 47.5%—13.7% less than for the pond samples. Considerable variation in sex ratios was found between ponds sampled in the same year and between collections from some of the ponds in different years. In each year many of the ponds studied were stocked with fry from the same tank, and where there was departure from the expected 50:50 sex ratio this may have occurred in the pond before the fish were 7 weeks old. We do not know whether the tendency toward maleness is the result of differential sex mortality or sex reversal. Slow growth appears to be associated with a preponderance of males. No relation was found between sex ratios and certain chemical and physical conditions in the ponds. (Auth.)

10385. Rachlin, Joseph Wolfe, and Alfred Perlmutter (Dept. of Biology, New York Univ., New York, N. Y.). 1968. RESPONSE OF AN INBRED STRAIN OF PLATYFISH AND THE FATHEAD MINNOW TO ZINC. Progr. Fish Cult., 30(4): 203-207.

A study of the responses of a population of fathead minnows (Pimephales promelas) and a population of inbred platyfish (Xiphophorus maculatus) to concentrations of zinc was made. The inbred platyfish were slightly more than 1.5 times more resistant to zinc than the tested fathead minnows. The inbred platyfish also exhibited a sex difference in their dose response: the females were more resistant than the males. The possibility of using the inbred platyfish as a bioassay animal for studies of aquatic toxicants is suggested. (Authors)

10386. Heaton, LeRoy H., and George Post (Colorado Cooperative Fishery Unit, Colorado State Univ., Ft. Collins, Colo.). 1968. TISSUE RESIDUE AND ORAL SAFETY OF FURAZOLIDONE IN FOUR SPECIES OF TROUT. *Progr. Fish Cult.*, 30(4): 208-215.

Furazolidone, N(5-nitro-2-furfurylidene)-3-amino-2-oxazolidone, was tested for tissue residue accumulation and safety in 4 trouts (*Salmo trutta*, *S. gairdneri*, *S. clarki*, and *Salvelinus fontinalis*). This drug has proved to be effective in the treatment of salmonid furunculosis. A dose level of 35 mg of furazolidone per kilogram of fish per day for 20 days was orally administered in the tissue residue studies. The highest average amount of furazolidone was 0.482 ppm found in brown trout muscle on the 10th day of treatment. Residues averaged less than 0.075 ppm in all species of trout by the 10th day post-treatment. Furazolidone was given orally at a dose level of 50 mg per kilogram of fish per day for 40 days in oral safety studies. No mortalities were attributed to furazolidone. Palatability was evaluated by initially feeding 70 g of furazolidone per 100 lb of food, and subsequently increasing the level to a maximum of 210 g per 100 lb of food, if rejection of lower levels of drug was not observed. The highest acceptable dose for brown trout was 90 g per 100 lb of food; for rainbow trout, 190 g per 100 lb of food. Brook trout and cutthroat trout fingerlings accepted 170 g per 100 lb of food. (Authors)

10387. Foye, Robert E. (Maine Dept. of Inland Fisheries and Game, Augusta, Me.). 1968. THE EFFECTS OF A LOW-DOSAGE APPLICATION OF ANTIMYCIN A ON SEVERAL SPECIES OF FISH IN CRATER POND, AROOSTOOK COUNTY, MAINE. *Progr. Fish Cult.*, 30(4): 216-219.

Fintrol-5 containing 1% antimycin was used at a concentration of 0.5 ppb of the active ingredient to reclaim a shallow 12-acre, soft-water pond. Effects on 11 species of fresh-water fish were observed, and the pond was treated with rotenone to assess results of the antimycin treatment. Yellow perch (*Perca flavescens*) and 5 cyprinid species were eliminated by the antimycin. Partial kills occurred among brook trout (*Salvelinus fontinalis*) and northern redbelly dace (*Chrosomus eos*). White sucker (*Catostomus commersoni*) and burbot (*Lota lota*) showed no effects from the antimycin treatment. (Auth.)

10388. Steucke, Erwin W., Jr., Leonard H. Allison, Robert G. Piper, Russell Robertson, and J. T. Bowen. (Bur. of Sport Fisheries and Wildlife, La Crosse, Wis.). 1968. EFFECTS OF LIGHT AND DIET ON THE INCIDENCE OF CATARACT IN HATCHERY-REARED LAKE TROUT. *Progr. Fish Cult.*, 30(4): 220-226.

Lake trout (*Salvelinus namaycush*) were reared from hatching stage in either covered or uncovered environments, and subgroups were fed three diet variations. Fish that developed cataract were fin-clipped for identification. At the end of a 3-year period each subgroup was divided and half was placed in opposite photo conditions. Each group was duplicated throughout the experiment. Examination of the fish indicated 3.9% incidence of cataract in fish that were covered and 76% incidence in fish that were uncovered. When light conditions were reversed, the incidence of cataract in those fish that had been covered increased from 3.9% to 74% during the next year. No cataract regression was noted in the fish that were moved from an uncovered to a covered situation. No differences in the incidence of cataract could be attributed to diet. (Authors)

10389. Jochimsen, Werner, and Gerald Bedell (Calif. Dept. of Fish and Game, Sacramento, Calif.). 1968. MALFORMED YOLK SACS OBSERVED IN CHINOOK SALMON FRY DURING TESTS OF BARREL-TYPE INCUBATORS. *Progr. Fish Cult.*, 30(4): 227-229.

During tests of experimental barrel-type incubators on chinook salmon fry (*Oncorhynchus tshawytscha*) almost all of the alevins which hatched and were held in the barrels developed varying degrees of yolk-sac malformation. Several times this abnormality resulted in heavy mortality. Possible causes for the condition are suggested and discussed. (Authors)

10390. Marnell, Leo, and Don Hunsaker, II (Colorado State Univ., Ft. Collins, Colo.). 1968. CONFINEMENT OF EXPERIMENTAL FISH. *Progr. Fish Cult.*, 30(4): 229.

A durable, lightweight live-box for trout is described. A nylon bag is attached along its top to a frame made of rigid plastic pipe, and along its bottom to a frame of pipe (similar dimensions) that can be weighted by filling with sand and plugging.

10391. Jordan, Fred P., and Howard D. Smith (Fisheries Research Board of Canada Biological Station, Nanaimo, B.C., Canada). 1968. AN ALUMINUM STAPLE TAG FOR POPULATION ESTIMATES OF SALMON SMOLTS. *Progr. Fish Cult.*, 30(4): 230-234.

A tag modified from an aluminum paper staple and suitable for marking young salmon for population estimates is described, and its performance is evaluated. The tags offer several advantages over fin clipping. They are applied and recovered easily and quickly, and do not require handheld inspection of individual fish in the recovery process. They offer a wide range of identifying codes and make possible a much larger sample. (Authors)

10392. Benoit, Duane (Fed. Water Pollut. Control Admin. Natl. Water Quality Lab., Duluth, Minn.). 1968. NUTRITION STUDY FOR MAINTAINING YELLOW PERCH FINGERLINGS IN THE LABORATORY. *Progr. Fish Cult.*, 30(4): 234.

Several groups of wild yellow perch (*Perca flavescens*) fingerlings were fed different diets. Weights calculated before and after special feeding indicated that diets should be one of the following: (1) ground beef liver; (2) ground beef liver mixed with trout food; or (3) trout food plus a ground beef liver-trout food mixture used as a supplement. (Auth.)

10393. Snow, J.R. (Marion National Fish Hatchery, Marion, Ala.). 1968. THE OREGON MOIST PELLET AS A DIET FOR LARGEMOUTH BASS. *Progr. Fish Cult.*, 30(4): 235.

The Oregon Moist Pellet was tested as a growing ration for largemouth bass (*Micropterus salmoides*) fingerlings during the 1967 production season. From three 0.1-acre ponds in which fingerlings were fed OMP at a rate of 2.3% to 5.0% of body weight per day for 81, 81, and 90 days, respectively, the harvest rates were 1,880, 2,560, and 3,280 lb per acre; feed conversions were 1.85, 1.33, and 1.62; and feed and labor costs were 62, 43, and 32 cents per pound of fish gained, respectively.

10394. Hennick, Daniel P., Larry B. Edfelt, and Martin F. Eaton (Alaska Dept. of Fish and Game, Kodiak, Alaska). 1968. USE OF A LACUSTRINE ENVIRONMENT BY PINK AND CHUM SALMON. *Progr. Fish Cult.*, 30(4): 236-238.

Fish passage facilities for the impassable falls on Frazer River, Kodiak Island, Alaska, have permitted the influx of a natural population of pink and chum salmon (*Oncorhynchus gorbuscha*, *O. keta*) to use a new spawning environment. Some of these fish have passed through the lake and spawned in the inlet streams to Frazer Lake. A late chum fry migration was noted in 1967, and the lake has apparently been a nursery area for chum salmon fry and a rearing area for a small group of pink salmon. (Authors)

10395. Thomas, Allan E., and J.M. Shelton (Bur. of Sport Fisheries and Wildlife, Salmon-Cultural Lab., Longview, Wash.). 1968. OPERATION OF ABERNATHY CHANNEL FOR INCUBATION OF SALMON EGGS. Bureau of Sport Fisheries and Wildlife Technical Paper 23. 19 p.

A spawning and incubation channel constructed in 1959 on Abernathy Creek near Longview, Washington, has been used for seven seasons to incubate fall chinook salmon (*Oncorhynchus tshawytscha*) and chum salmon (*O. keta*) eggs. Survival of eggs from both species was higher than reported for other channels and controlled-flow projects. Studies included effects of sedimentation, egg planting density, and stage of egg development at planting on survival. In early experiments sediment in the upper sections substantially reduced survival. In

later experiments, after the construction of a sand trap and settling chamber, survivals were significantly increased. Planting densities were increased to a maximum of 435 eggs per square foot without significant reduction in survival. This is about three times that recommended for spawning channels. Peak migrations occurred at about 1,800 temperature units for chinook salmon and 1,700 temperature units for chum salmon. Survivals from eyed egg to migrant for chinook salmon was from 68.6 to 76.5 percent. Survivals for chinook eggs planted before water hardening was 14.6 percent but the results were influenced by unfavorable water temperatures. Survivals for chum salmon ranged from 75.3 to 76.5 percent for eyed-egg plants, 87.8 percent for waterhardened, green-egg plants, and 71.9 percent for pre-waterhardened green-egg plants. (Authors)

10396. Tortosa, Richard L. (Bur. of Commercial Fisheries Biological Station, Marquette Mich.). 1963. EFFECTS OF LAMPREY LARVICIDES ON INVERTEBRATES IN STREAMS. U.S. Fish and Wildlife Service Special Scientific Report--Fisheries No. 572. 13 p.

The study was conducted on five streams tributary to Lake Superior and four tributary to Lake Michigan. Samples of the bottom fauna before and after chemical treatment revealed that most groups of aquatic organisms were not adversely affected by exposure to larvicides. The total number of invertebrates was smaller one week after treatment than before treatment, increased somewhat by six weeks after treatment, and had returned to pretreatment levels one year after treatment. Aquatic insects were affected less than other organisms, and invertebrates were more severely affected and recovered more slowly in areas of sand and detritus than in riffle areas. (Auth.)

10397. Dovel, David G., and John R. Clark (Bur. of Sport Fisheries and Wildlife, Sandy Hook Marine Lab., Highlands, N. J.). 1963. THE 1965 SALT-WATER ANGLING SURVEY. Bureau of Sport Fisheries and Wildlife Resource Publication 67. 51 p.

The U.S. Bureau of Census conducted The 1965 Salt-Water Angling Survey as an adjunct to a survey of all fishing and hunting activity in the United States, the 1965 National Survey of Fishing and Hunting. This survey consisted of household interviews of approximately 43,500 persons in 16,000 households 12 years of age or older. Those persons contacted in the National Survey of Fishing and Hunting identified as salt-water anglers were later interviewed for The 1965 Salt-Water Angling Survey. The number of geographical divisions for reporting the catches was limited to seven which were chosen to coincide where possible with biogeographical areas rather than with political divisions. Completed interview records were obtained from 1,566 persons or about 95% of those originally identified as salt-water anglers. This information was used to estimate the total catch of the 3,236,000 salt-water anglers in the United States. The catches were compiled by 76 species groups. Although the number of anglers shows a substantial increase from 1960 to 1965 (33% for all regions combined), the number of fish caught increased only 16 percent. The weight of fish caught increased 7%.

10398. Boccardy, Joseph A., and Willard M. Spaulding, Jr. 1968. EFFECTS OF SURFACE MINING ON FISH AND WILDLIFE IN APPALACHIA. Bureau of Sport Fisheries and Wildlife Resource Publication 65. 20 p. illus.

This report on the effects of strip and surface mining on the fish and wildlife resources in eight Appalachian States is based in part on observations made during a tour of strip and surface mined areas by the authors, as members of a team of specialists from six Federal agencies. Surface mining has caused extensive damage to fish and wildlife habitats and populations. A total of 832,605 acres of land have been disturbed; 81 percent of these are in Ohio, Pennsylvania, and West Virginia. More than 5,000 miles of Appalachian streams and 13,800 acres of impoundments have been seriously contaminated by acid mine water, some of it from surface mining. Additional water acreage has been adversely affected by tremendous quantities of silt and sediment. Reclamation of mined lands is needed. Three of the eight States visited in 1965-66 had no laws requiring restoration of

strip-mined lands, and other States needed stronger laws and more enforcement (Virginia and Tennessee have since passed laws governing strip mining). Reclamation as currently practiced in the Appalachian region does not adequately restore mined lands to minimal standards necessary to protect and improve fish and wildlife resources. (Authors)

10399. Simmons, David C. (Tropical Atlantic Biological Lab., Bur. of Commercial Fisheries, Miami, Fla.). 1968. MATURITY AND SPAWNING OF SKIPJACK TUNA (*Katsuwonus pelamis*) IN THE ATLANTIC OCEAN, WITH COMMENTS ON NEMATODE INFESTATION OF THE OVARIES. U. S. Fish and Wildlife Service Special Scientific Report--Fisheries No. 580. 17 p.

Ovaries were examined from 537 fish collected in the eastern tropical Atlantic, western tropical Atlantic, and off New York. The reported incidence of larval and juvenile *K. pelamis* was also reviewed. The minimum fork length of skipjack tuna at maturity was 435 mm in the eastern tropical Atlantic, and 410 mm in the western tropical Atlantic. All ovaries collected off New York were in an early stage of development. The percentage of skipjack tuna near spawning or recently spawned was greater in the western tropical Atlantic than in the eastern tropical Atlantic. Skipjack tuna spawn throughout the year in the areas studied in the tropical Atlantic. The number of eggs per spawning for fish 465 mm to 809 mm long was 262,000 to 1,331,000. Nematodes identified as *Philometra* sp. and Spiruroidea infested the ovaries of about 90 percent of the mature skipjack tuna. Both taxa were found in the ovaries of tuna collected in all three areas. (Auth.)

10400. Latta, W.C. 1968. SOME FACTORS AFFECTING SURVIVAL OF YOUNG-OF-THE-YEAR BROOK TROUT, *Salvelinus fontinalis* (Mitchill), IN STREAMS. Michigan Dept. of Conservation Research and Development Report No. 140. 25 p.

Survival of brook trout during the first year of life was considered in relation to (1) territorial behavior, (2) other segments of the trout population, (3), starvation and (4) the amount of groundwater entering the stream. No relationship was found between abundance of fingerling progeny and the number of spawners. Survival of eggs in the redds is usually high. Although little is known about losses of fry during emergence from the redds, it is presumed that most of the mortality occurs shortly after emergence. Territories are most likely formed upon emergence. Fry that have less desirable territories, or no territories at all, are less likely to survive. It has not been shown that predation by either brook trout or other vertebrates accounts for loss of fry. It was demonstrated that brook trout fry are relatively long-lived in the face of starvation, but the possibility exists that a rather short period of starvation may deter them from feeding effectively or assimilating the food that they do obtain. Death rate of trout fry from starvation increases with a rise in water temperature. Groundwater levels probably act as a physical factor of the environment to regulate the number of trout in the stream. (Auth.)

10401. Kleinert, Stanton J., Paul E. Degurse, and Thomas L. Wirth. 1968. OCCURRENCE AND SIGNIFICANCE OF DDT AND DIELDRIN RESIDUES IN WISCONSIN FISH. Wisconsin Dept. of Natural Resources Technical Bulletin No. 41. 43 p.

AUTHOR INDEX FOR VOLUME 13

- Acara, A.H., 10189
 Ackerman, Gary, 10359
 Ackman, R.G., 10272, 10300
 Addison, R.F., 10300
 Agris, Paul F., 9581
 Alabaster, J.S., 10068
 Alderdice, D.F., 9927, 9931
 Alexander, Gaylord R., 9569, 9683
 Ali, M.A., 10121, 10287
 Allen, K. Radway, 9740
 Allen, Norris, 9711
 Allen, Richard L., 10321
 Allison, Leonard H., 10388
 Allison, Ray, 10245, 10247
 Ambrosius, H., 10141, 10142
 Amend, Donald F., 10078, 10231
 Anctil, M., 10287
 Andersen, B., 9589
 Anderson, D V., 10026, 10027
 Anderson, John M., 9570, 9571
 Anderson, Richard O., 10237
 Anderson, R. Stewart, 9734
 Andrews, Austin K., 10186
 Angelovic, Joseph W., 9695
 Ankorion, J., 9758
 Anonymous, 9684
 Applegate, Richard L., 9665, 9876,
 9896, 10176, 10276
 Applegate, Vernon C., 9742
 Arai, Hisao P., 10022, 10023
 Arai, Ryoichi, 9829
 Armstrong, Robert H., 10190
 Arnold, John G., Jr., 9895
 Arp, Arthur, 9677
 Arurkar, Suresh K., 10265
 Aspinwall, Nevin, 10252
 Atlantic Salmon Journal, 10333
 Atton, F.M., 10264
 Au, David W.K., 9622, 9623
 Avault, James W., Jr., 10240
 Averett, Robert C., 9670

 Bachmann, Roger W., 10357
 Bachop, William, 10144
 Backiel, T., 10099
 Bailey, R.G., 9792
 Baker, W. Donald, 9887, 9894
 Baldwin, Norman L., 9704
 Ball, Ian R., 10070, 10071
 Ball, R.C., 10253
 Banks, Joe L., 9619
 Barkuloo, James M., 9798
 Bartlett, Martin R., 9588, 10348
 Baxter, G.T., 9991
 Bayless, Jack D., 9660, 9854
 Bayley, Suzanne, 10296
 Baylor, Edward R., 9804, 9805
 Baytr, A.K., 9954

 Beamish, F.W.H., 10200
 Bear, George, 9721
 Becker, C.D., 9697, 9698, 10000
 Beckett, James S., 9588, 9910
 Beckford, M.L., 9750
 Bedell, Gerald, 10389
 Beers, J.R., 9592
 Behmer, David J., 10360
 Beil, Joseph, 10182
 Beirne, Caperton, 10087
 Bell, G.R., 9574, 10215
 Benoit, Duane, 10392
 Benson, Norman G., 10025
 Bentley, Wallace W., 10179
 Berger, Bernard L., 9653
 Beridze, I.O., 9846
 Bern, Howard A., 10129
 Berra, Tim M., 10002
 Berryman, M.H., 10110
 Berst, A.H., 9737
 Beryerle, George B., 9674
 Bilinski, E., 9738, 10269
 Bilton, H.T., 10203, 10283, 10286
 Bingham, C. Rex, 9965
 Binna, Niles Allen, 9961
 Birman, I.B., 9766
 Bishop, H.D., 9745
 Blackburn, Robert D., 10238
 Boccardy, Joseph A., 10398
 Boeseman, M., 9974
 Bond, Carl E., 10373
 Bonham, Kelshaw, 10188
 Bonn, Edward W., 9891
 Bonner, William R., 9882
 Booke, Henry E., 10274
 Borgeson, David P., 9599
 Borodicova, Nina D., 10029
 Bothern, C.R., 10206
 Bottroff, Lawrence, 10329
 Bouck, G.R., 10253
 Bowen, J.T., 10012, 10388
 Bowling, Michael L., 9858, 9885
 Brady, David N., 9762
 Branham, Lowell, 9598
 Branson, Branley A., 10074
 Brar, S.S., 10017
 Brett, J.R., 9577, 9579
 Bridges, David W., 10193
 Broach, Dick, 9986
 Brocksen, Robert W., 9585
 Brown, M.E., 9794
 Brown, Seward R., 9928
 Brown, V.M., 9657, 10067, 10110
 10111
 Brunson, W.D., 9697, 10000
 Bruemmer, Fred, 9768
 Brynildson, Oscar M., 9749, 10091
 Buckley, Raymond M., 9607

- Buckow, Ed, 9767
Budd, J. C., 10311
Buerkle, Udo, 9731, 10209
Buhler, Donald R., 10146, 10148
Bull, C. J., 10011
Bullock, G. L., 9918, 9979, 10019
Bulow, Frank J., 9631
Buntz, Jon, 9880
Burgess, J. E., 9646
Burggraff, Leo J., 9996
Burke, W. David, 10167
Burress, Ralph M., 9617
Burrows, Roger E., 10221
Bursa, Adam S., 10216
Busbee, Raymond L., 9858, 9984
Buterbaugh, Galen L., 9629
Butler, Robert L., 9676
Buttkus, H., 9575

Caillouet, Charles W., Jr., 9901
Cairns, John, Jr., 9752, 9975, 10064,
10128, 10222
Calaprice, John R., 9600
Calderoni, Pompo, 9769
Cameron, James N., 9720
Campbell, Gordon, 9922
Carbery, J. T., 10135
Carlander, Kenneth D., 10058
Carlisle, John G., Jr., 10328
Carlson, Clarence A., 10058
Carlson, C. P., 9918, 10159
Carlton, William G., 10353
Carnes, W. Cape, 9877
Carothers, John L., 10247
Carpenter, George F., 10199
Carroll, Billy B., 9856
Carrothers, P. J. G., 9751
Carter, James P., 10105
Carter, Neal M., 10291
Carter, Neil Enoch, 10228
Carter, Wilfred M., 9685
Cartier, Denis, 10018
Carver, Dudley C., 9652, 9888
Caulfield, W., 9942
Cerini, C. P., 10151, 10152
Chadwick, Harold K., 10327, 10378
Chandler, Clay M., 9787
Chapman, D. W., 10259
Chapman, George B., 10297
Charnell, Robert L., 9622, 9623
Chastain, G. A., 9664
Chaston, I., 10217
Cheek, Randall P., 9871, 10326
Chen, T. R., 10132
Chernikova, V. V., 9958
Childers, William F., 9944
Chkhaidze, R. I., 9846
Clady, Michael D., 9987
Claffey, Francis J., 9874
Clark, John R., 10397

Clarke, W. Craig, 10262
Clem, L. W., 10154
Clemens, Howard P., 9673
Clifford, Hugh F., 10365
Clugston, James P., 9855
Coble, Daniel W., 9594
Coche, Andre G., 10054
Codegone, M. L., 9703
Colby, Peter J., 10008
Combs, Bobby D., 9999, 10221
Conder, John, 9853, 9862
Conover, Kelly R., 10079
Cooper, Edwin L., 9552
Copeland, B. J., 9719
Cordone, Almo J., 10112
Corkum, Kenneth C., 9810
Cornwell, G. W., 9688
Costa, H. H., 9724
Cowell, Bruce C., 10133
Cowey, C. B., 10377
Crane, J. W., 9705
Croker, Robert A., 10294
Cross, Frank B., 10047
Guerrier, J. -P., 10264
Cushing, D. H., 10314
Cushing, John E., 9600

Dahl, Frederick H., 10173, 10236
Dahlberg, Michael L., 9904, 10009
Davis, Billy J., 10076
Davis, Gerald E., 9585
Davis, James R., 9871
Davis, James T., 9659, 9866, 9867,
9868
Davis, J. C., 9579
Davis, Sterling P., 9627
Daw, Nigel W., 9687
Dawson, C. E., 9555
Day, Dwane E., 9770
Deacon, James E., 10103
Degurse, Paul E., 10325, 10401
Delisle, Claude, 10288
Dell, Michael B., 6979
Deluise, Frank J., 10101
Demaree, Richard S., Jr., 10075
Demchenko, I., 9771
De Santo, Robert S., 9700
De Sylva, Donald P., 9818
Deubler, Earl E., 10107
Deuel, David G., 10397
DeVaney, Thomas E., 10364
De Villiers, J. P., 9973
Dewilde, Mary Anne, 9730, 9909
Deyoe, C. W., 10383, 10104, 10126
Dijkgraaf, S., 9814
Dimond, John B., 10057
Division of Fishery Research, 10315
Dobie, John, 9842
Donaldson, Edward M., 9905, 10260,
10262

- Donaldson, Ivan J., 10308
Donaldson, John R., 9926
Dorris, Troy C., 10076
Doudoroff, Peter, 9904
Douglas, Neil H., 9658
Drucker, B., 9593
Drury, D.E., 10090
Dryer, William R., 10182, 10256
Duck, Harvey, 9759
Duever, Michael J., 10185
Duffy, J.M., 10372, 10381
Duffy, J.R., 9911
Duncan, Richard N., 10308
Duthie, Hamish C., 10214
Dutton, J.W.R., 10066
Dyer, W.J., 10267
- Eales, J.G., 10090, 10281
Eaton, Martin F., 10394
Ebeling, A.W., 10132
Edelhauser, Henry F., 10201
Eddy, F.B., 9637
Edfelt, Larry B., 10394
Edmundson, Eldon, 10259
Edwards, Stephen R., 10379
Egorova, M.N., 9960
Eisler, Ronald, 9621, 9755, 9756
Eller, Lafayette L., 10186
Elliott, J.M., 10334
Elrod, Joseph H., 9873
Emel'yanov, S.V., 9835
Engen, Paul C., 10371
English, T. Saunders, 9726
Enomoto, Yoshimasa, 10036
Erdman, Donald S., 9760, 10180
Erickson, James G., 9763
Espinoza, F.A., Jr., 9670
Evelyn, T.P.T., 9597
Everest, F.E., 10259
Everhart, W. Harry, 9900
- Fagerlund, Ulf H., 9905, 9828, 10260
Fahay, Michael P., 10193
Faleeva, T.I., 9847
Fast, Arlo W., 9995
Fawell, J.K., 10067
Fenderson, Owen C., 9900
Ferguson, Denzel E., 9965, 10167
Fielding, James R., 10241
Fillion, D.B., 10324
Finucane, John H., 9857
Fisher, Hartwig, 10120
Fish, Frederic F., 9889, 10197
Fish, G.R., 10292
Fitz-Earle, M., 9913
Fleminger, Abraham, 9789
Flerov, B.A., 9782
Flick, William A., 9978, 10004
Flickinger, Stephen, 9640
Floyd, Hilton, 10290
- Foerster, John W., 10109
Foerster, R.E., 10249
Follis, Billy J., 9891
FAO of the U.N., 9813
Fore, Paul L., 9692
Forney, John L., 9708, 10014
Forrester, C.R., 9927
Foster, Neal R., 9752
Fotiev, A.V., 9772
Fowler, Laurie G., 9619, 9935
Fox, Alfred C., 10276
Foye, Robert E., 10387
Franklin, Donald R., 10060
Frantz, Ted C., 10112
Fraser, Doris I., 10267
Fraser, J.M., 10223, 9675
Fraser, T.B., 10332
Fraser, Thomas H., 10346
Frassetto, R., 9713
Freeman, H.C., 9916
Freeman, R.I., 9628
Fremling, Calvin R., 10169
Frey, John E., 9864, 9884
Friis, R.R., 10154
Frost, W.E., 9794, 10354
Fry, F.E.J., 10026, 10311
Fry, James P., 10181
Fryer, John L., 10078, 10231
Fujihara, M. Paul, 10321
Fujino, Kazuo, 10131
Fuller, Hubert T., 10137
Fulmer, Bruce A., 9601
Funk, John L., 10366
- Gakstatter, Jack H., 10280
Galkina, Z.I., 9848
Gardner, L.J., 10269
Garnett, D.G., 9932
Garrison, Robert L., 9985
Gasaway, Charles R., 9613, 10234
Geagan, Donald, 9895
Gebhardt, Gary A., 10323
Gee, J.H., 10261
Geen, G.H., 10170
Gerbil'skii, N.L., 9849
Ghittino, P., 9703
Gibson, R.N., 9715, 9816
Gilhousen, P., 10127
Gill, C.A., 9903
Gill, Charles D., 9943
Gillespie, G.J., 10331
Girsa, I.I., 9946
Giudice, John J., 9869
Glenn, C.L., 10263
Godfrey, H., 10283
Goldberg, E.D., 10102
Gooch, Burwell C., 9840
Gooch, Vijaya, 10058
Gorbman, Aubrey, 9831
Gotshall, Daniel W., 10123

- Graff, Delano R., 10226
Graham, Joseph J., 10210
Grant, P. T., 10374, 10375
Greer, G. L., 10312
Gregory, Richard W., 10191
Griffin, J. J., 10102
Gring, David M., 9917
Grinols, Richard B., 9943
Griswold, Bernard L., 9994
Grizzell, Roy A., Jr., 9641
Gronlund, William D., 9925
Groutage, Thomas M., 9976
Groves, Alan B., 9694
Gruchy, C. G., 9941
Guelin, Antonina, 9836
Gunderson, Donald R., 10198
Gunning, Gerald E., 9744, 10002
Gunstrom, Gary K., 9980
Gustafson, P. F., 9784, 10017
Gutherz, Elmer J., 9669
- Haas, James B., 10079
Hackney, Peter A., 9644
Hadaway, W., 10322
Haedrich, Richard L., 10348
Haen, Peter J., 10134
Haga, Hideo, 10044
Haga, Yoshiko, 10044
Hale, James B., 9671
Hale, John G., 10175
Haley, Richard, 9627
Hall, William M., Jr., 10087
Halsey, T. G., 9906
Hambric, R. N., 9662
Hane, Satoshi, 9957
Hanks, Robert W., 10295
Hanson, Arthur J., 9586
Hanson, Willis D., 10181
Hara, Toshiaki J., 9831
Hardy, C. J., 9748
Hardy, Jerry D., 9693
Hardisty, M. W., 9827
Harrel, Richard C., 10076
Hart, I. C., 9701
Hartman, G. F., 9903
Hartman, W. L., 9593
Harvey, H. H., 9819, 10206
Hashimoto, Yoshiro, 10045
Haskell, D. C., 9628
Hasler, Arthur D., 9551, 9608, 9938, 9964, 10318
Hassler, W. W., 10168
Hattori, Shigemasa, 10048
Haw, Frank, 9607
Hawthorne, Vernon M., 9676
Haynes, L. J., 9815
Healey, M. C., 9732
Heard, W. R., 9593, 9678
Heaton, LeRoy H., 10386
Hedlich, Rolf, 9791
- Helm, William T., 9695
Hemmings, C. C., 9793
Henley, James P., 9893
Hennick, Daniel P., 10394
Herald, Earl S., 10345
- Hergenrader, Gary L., 9551, 9938
Herman, Roger Lee, 10163
Herman, Sidney S., 10083
Herting, Gerald E., 9564, 9981
Hesselberg, Robert J., 9617
Hester, F. Eugene, 9879
Hettler, William F., Jr., 10178
Heyland, Joan, 9685
Hickman, Cleveland P., Jr., 10117, 10118, 10119, 10273
Higashi, Hideo, 10033, 10034
Higer, Aaron L., 9638
Hill, David W., 9725
Hiltibran, Robert C., 9558
Hingley, J., 10300
Hiyama, Yoshio, 10031
Hoar, W. S., 10206
Hobson, Edmund S., 10335
Hochachka, P. W., 10376
Hodgins, Harold O., 9925
Hoffarth, Ray, 9853
Hoffman, G. L., 10145
Hogan, James W., 9615, 9936, 10265, 10270
Hogman, Walter J., 10304
Holcik, Juraj, 10030
Holeton, G. F., 9797, 9799, 9800
Honstead, John G., 9762
Hornbeck, Russell G., 9663
Hosie, Michael J., 10373
Hourston, A. S., 9736
Houston, A. H., 9730, 9909
Howard, T. E., 10069
Howell, Henry H., 9861
Howell, John H., 9743, 10347
Hoyle, R. J., 9916, 10219
Hreha, Larry H., 10082
Huang, Chau-Ting, 10273
Hubbs, Clark, 10138, 10187
Huck, Lois Lee, 9744
Hudson, Patrick L., 10133
Huggett, R. J., 10102
Hughes, Janice S., 9658, 9659, 9866, 9867, 9868
Hulquist, Robert G., 9604
Humphreys, R. M., 9573
Hunn, Joseph B., 9611, 9902, 10230
Hunsaker, Don, II, 10390
Hunt, Robert L., 9899
Hunter, John, 9919
Hyde, Jackson M., 9627
- Ibragimov, I., 9949
Idler, D. R., 9802, 9916, 9923, 10219

- Idyll, Clarence P., 10150
 Ihm, William J., 9990
 Ikeda, Shizunori, 10039, 10040
 Inaba, Makoto, 9832, 9833
 Ingram, Paul G., 10080
 Ingram, W. M., 9727
 Inslee, Theophilus, 9673
 Irie, Takaaki, 10032
 Ishii, Seinosuke, 10033, 10034
 Ishii, Takeo, 10041
 Ishioka, Kiyohide, 10031
 Ito, Yohei, 9970
- Jackson, Sam W., Jr., 9655
 Jackson, William B., 10353
 Janssen, Werner A., 9668
 Javaid, M. Yaqub, 9570, 9571
 Jefferies, D. F., 10066
 Jenkinson, D. W., 10203
 Jensen, Mogens H., 10160
 Jochimsen, Werner, 10389
 John, Kenneth R., 9917
 Johnson, B. G. H., 9742
 Johnson, James E., 10194
 Johnson, M. G., 9630
 Johnson, Ray C., 9773
 Johnston, C. E., 10281
 Johnston, Kenneth H., 9661
 Jolly, V. Hilary, 9712
 Jonas, R. E. E., 9738
 Jones, J. W., 9690, 9691
 Jordan, Fred P., 10391
 Jordan, D. H. M., 9657
 Joyner, T., 9755
 Judd, J. M., 9786, 10254
 Kabata, Z., 9915
 Kajihara, Takeshi, 10031
 Kalber, Frederick A., 9818
 Kalff, Jacob, 9583
 Kalmijn, A. J., 9814
 Kaneko, Tokugoro, 10033, 10034
 Kang, Tagay, 10131
 Kariya, Teiji, 10044
 Karlov, V. I., 9954
 Kato, Susumu, 9625, 10336
 Katoh, Hidetsugu, 10048
 Kawada, Izumi, 10046
 Kawazu, Kazuyoshi, 9832, 9833
 Kearn, G. C., 10149
 Keast, Allen, 9914, 10207, 10212
 Kelley, D. W., 9959
 Kelley, John R., Jr., 9652, 9873
 Kelley, John W., 10229
 Kelly, William H., 9709, 9710
 Kempinger, James J., 10115
 Kendall, Arthur W., Jr., 10086
 Kendall, J. I., 10342
 Kennedy, Harry D., 9618
 Kennedy, W. A., 10028, 10310
 Kerns, Orra E., Jr., 9926
- Kesteven, G. L., 9714
 Keup, L. E., 9727
 Khan, Jamil A., 9722
 Kikuchi, Takaaki, 10033, 10034
 Kimata, Masao, 10046
 Kimura, Ikuo, 9970
 King, George R., 10256
 Kipling, Charlotte, 10354
 Kirka, Anton, 9795
 Kirkland, Leon, 9885
 Klein, Catherine, 9830
 Klein, Hans T., 9789
 Kleinert, Stanton J., 10325, 10401
 Knapp, Stuart E., 9704
 Knowles, Charles O., 9936, 10265, 10270
 Knudsen, George J., 9671
 Kobayashi, H., 10121
 Kocurova, Eva, 9723
 Kohler, A. C., 9929
 Kol'gaev, A. M., 9850
 Kolipinski, Milton C., 9638
 Kollmann, Albert, 9811
 Konar, S. K., 10003
 Korn, Lawrence, 10080
 Kovacs, L., 9963
 Kover, A., 9963
 Koyama, T., 10051
 Krantz, George E., 10085
 Krisnandhi, Sulaeman, 9643
 Krokkin, E. M., 9765
 Krupp, Marcus A., 9957
 Kudrna, Joel J., 10361
 Kuntz, Robert E., 9812
 Kussat, Rick H., 10023
 Kutty, M. Krishnan, 10218
 Kutty, Methil Narayan, 10275
 Kwain, W., 9764
- Laastuen, L. E., 9935
 Lablin, Daniele, 9836
 Lagios, Michael D., 10344
 Lake, J. S., 9609
 Lantz, Kenneth E., 9867
 Larimore, R. R. Weldon, 10185
 Larkin, P. A., 9736
 Larson, Omer R., 9636
 Lasater, J. E., 9772
 Latapie, Walter R., Jr., 9977
 Latta, W. C., 10400
 Laurence, Geoffrey C., 9872
 Laurs, R. Michael, 9587
 Lauzier, L. M., 9582
 Lawler, G. H., 9913
 Lawrence, J. M., 10239
 Lawson, Walter, 10330
 Lebedeva, G. D., 9845
 Leff, Eugene, 9707
 Legault, Romeo O., 10065, 10199, 10288
 Lehmann, R., 10142
 Lennon, Robert E., 9620, 9626

- Leonenko, E. P., 9851
Leshcheva, T. S., 9946
Levin, Catherine B., 10205
Lewis, William M., 9632, 9640, 9645, 9983, 10172
Lindsey, C. C., 10285
Linn, D. Wayne, 9695
Little, James D., 9654
Lloyd, R., 9610
Lockard, Dale V., 10233
Loeffel, Robert E., 10077
Longacre, D. L., 9628
Lonsdale, E. M., 9991
Loos, Jules J., 9752, 10128
Loring, D. H., 10313
Lorio, Wendell J., 9651
Louder, Darrell E., 9887
Lowe, Jack I., 9650
Lowes, R. H., 10322
Ludke, J. Larry, 10167
Lukowicz, Mathias, 9803
Luk'yanenko, V. I., 9782
Lush, I. E., 10377
Lyles, Charles H., 9898
Lyman, Charles P., 10352
Lythgoe, J. N., 9788
- Maar, A., 9820
Macek, Kenneth J., 10279, 10320
Maciolek, J. A., 10059
MacGregor, John S., 10380
McKechnie, Robert J., 10382
MacKelvie, R. M., 9922
Mackenthun, K. M., 9727
MacLeod, J. C., 9565
MacNab, H. C., 9802
Magnin, Etienne, 9822, 10289
Maiwa, Takashi, 10031
Malsberger, R. G., 10151, 10152
Malyukina, G. A., 9945
Manar, Thomas A., 9753
Mansueti, Alice J., 9693
Manteifel', B. P., 9946
Manzer, J. I., 10204
Margolis, L., 10021, 10024
Markert, J. R., 10317
Marking, Leif L., 9615
Marnell, Leo, 10390
Martin, John Wilson, 9633
Martin, Richard Lee, 10227
Martin, Susan S., 9695
Massmann, William H., 9728
Mather, Frank J., III, 9588
Mathews, Stephen B., 10213
Mathis, W. P., 9642
Mathur, D. S., 9966
Maxfield, Galen H., 9971
Maxwell, James I., 9992
May, A. W., 9572
May, Edwin B., 9613
- Mayhew, James, 10355
McAlice, Bernard J., 10277
McBride, J. R., 9580, 10260
McCammon, George W., 9599
McCart, P., 9589
McCarty, Perry L., 9725
McCauley, James E., 9587
McCauley, R. W., 9998, 10284
McCleave, James D., 9590
McComish, Thomas S., 9982
McCormick, J. Michael, 9587
McCoy, Edward G., 9660
McCrimmon, H. R., 9630, 9764, 10196
McDermott, L. A., 10266
McDonald, Donald B., 10358
McDowall, R. M., 9672, 9696, 10293
McElwain, Ivan B., 10001
McErlean, Andrew J., 10083
McFadden, James T., 9569
McFarland, William N., 9717, 9775
McGill, Edward M., Jr., 9883
McLachlan, J., 10272
McLain, Alberton L., 10173
McNeil, W. J., 10125
Medcof, J. C., 10319
Meekin, Thomas K., 10321
Meeks, Robert L., 10089
Mense, James Burr, 10106
Meyer, Fred P., 9663, 10242, 10340
Meyers, Caldwell D., 9668
Mihursky, Joseph A., 10083
Miles, S. G., 10271, 10305
Millemann, Raymond E., 9704
Miller, Bruce Stuart, 9735
Miller, Daniel J., 10123
Miller, Lee W., 9605, 10382
Minckley, W. L., 10103
Mitrovic, V. V., 10110
Mitrovic, V. V., 10111
Mitsugi, T., 10051
Mitsui, Tetsuo, 9832, 9833
Miyazaki, C., 10051
Mizelle, J. D., 9705
Moav, Rom, 9758
Moewus-Kob, Liselotte, 10153
Monan, Gerald E., 9561, 10094
Moore, W. H., 10363
Moraes, David I., 9896
Morawa, F. W. Frithjof, 9821
Morris, Larry A., 10006
Mortimer, M. A. E., 9820
Moss, Sanford A., 9775
Mount, Donald I., 10073
Moyle, John B., 9790
Mraz, Donald, 10162
Muir, B. S., 10342
Mullan, James W., 9665, 9876, 9896
10176
Mullarkey, William G., 10081
Muncy, Robert J., 9656

- Muniak, S.E., 10017
 Muntyan, S.P., 9947, 9972
 Murdoch, Marianne B., 10108
 Murphy, Garth I., 10055
 Murray, A.R., 10171, 10306
 Muth, Kenneth M., 9900
 Myers, Betty June, 9812

 Nabiev, A.I., 9948
 Nahhas, Fuad M., 10379
 Nakamura, Eugene L., 10130
 Nakano, T., 9576, 9934
 Narver, David W., 9591, 9596
 Naumann, W., 9808
 Neate, Harry, 10224
 Nelson, D.J., 9785
 Nelson, D.M., 10017
 Nelson, J.S., 9907, 9920, 9921, 10174, 10337
 Nelson, William R., 10184
 Nelson-Smith, Anthony, 10362
 Nichols, Paul R., 10096
 Nicholson, H. Page, 9686
 Nigrelli, R.F., 9932
 Niwa, Hiroshi, 10038
 Noble, R.E., 9778, 10177
 Norden, Carroll R., 9553
 Northcote, T.G., 10170
 Nota, D.J.G., 10313
 Novak, Paul F., 10006
 Novotny, Anthony J., 9694
 Nowlan, Sandra S., 10267

 O'Connell, D., 9911
 Odemar, Melvyn W., 10123
 Ogawa, Yoshinori, 10043, 10049, 10050, 10052, 10053
 O'Hara, James, 10062
 Okutani, Koichi, 10046
 Olson, Donald E., 10384
 Omorov, E., 9949
 Ophel, I.L., 9786, 10254
 Orcutt, Donald R., 9677
 O'Rourke, Fergus J., 10134
 Orr, T.S.C., 9689
 Orsi, James J., 10370
 O'Sullivan, A.J., 9807
 Ouellette, R.P., 9841
 Ovchynnyk, Michael M., 9568
 Owens, Eben L., 10323

 Paim, U., 10312
 Paloheimo, J.E., 9929
 Pandian, T.J., 9757
 Pardue, Garland B., 9879
 Parker, John D., 9645
 Parker, Robert R., 9939
 Parker, Wayne, 10329
 Parsons, T.R., 10056, 10250
 Patriarche, Mercer H., 9680, 10165

 Patrick, Ruth, 10064, 10222
 Patriquin, David G., 9739
 Patten, Benjamin G., 10343
 Pauley, Gilbert B., 10321
 Paulik, G.J., 9736
 Pavlov, D.S., 9946
 Pearcy, William G., 10251
 Pearson, Lincoln S., 10079
 Pearson, William D., 10060
 Pechlaner, R., 9817
 Peek, Frank, 9666
 Pelczar, Michael J., Jr., 9711
 Perlmutter, Alfred, 9635, 9707, 10192, 10385
 Peterson, Hans H., 9682
 Pfeiffer, Peter W., 9880
 Pfister, C., 9808
 Phillippy, C.L., 9852
 Phinney, Duane E., 10009
 Piavis, George W., 10347
 Pickering, Quentin H., 10072
 Pierce, Phillip C., 9864, 9884
 Pilcher, K.S., 10078
 Piper, Robert G., 10388
 Pippy, J.H.C., 9584
 Piskarev, K.V., 9949
 Pletcher, F.T., 10209
 Poddubnyi, A.G., 9776
 Poon, Calvin P.C., 10101
 Popova, O.A., 9950
 Post, George, 10001, 10386
 Power, G., 10207
 Powers, Charles F., 10211
 Powles, P.M., 9932
 Pozar, Dusan F., 10007
 Prather, E.E., 9897
 Preston, A., 10066
 Price, Charles E., 10022
 Privol'nev, T.I., 9956
 Prost, Maria, 9837
 Provana, A., 9703
 Pugh, John R., 9561, 10094
 Pulliam, Ben R., 9677

 Qadri, S.U., 9567, 9841, 10301
 Quajjum, A., 9722
 Quimby, M.C., 9918
 Quistorff, Elmer, 9777

 Rabe, Fred W., 10124
 Rabin, Harvey, 10296
 Rachlin, Joseph W., 9635, 10385
 Racz, Maria, 9963
 Radtke, Larry D., 9556
 Rainwater, William C., 10176
 Raleigh, Robert F., 9741
 Randall, Clifford W., 10100
 Randall, D.J., 9780, 9781, 9797, 9799, 9800, 9801, 9955
 Rasmussen, C.J., 10161

- Rasmusson, Mary E., 10146, 10148
Ratledge, Hayden M., 9886
Raymond, Howard L., 10179
Reed, Edward B., 9721
Regier, H. A., 9989
Reid, K. B. M., 10374, 10375
Reimers, Paul E., 10077, 10302
Reingold, Melvin, 9988
Relyea, Kenneth, 10341
Reznichenko, P. N., 9972
Richard, Joseph D., 10258
Richards, William J., 9612
Richardson, Alison J., 9807
Rickards, William L., 10016
Ricker, W. E., 10257
Ridenhour, Richard L., 9601
Rinckey, Gordon R., 9857
Risebrough, R. W., 10102
Rivas, L. R., 9838, 10303
Roback, Selwyn S., 10064
Roberson, Kenneth, 9562
Roberts, E., 10322
Roberts, Travis, 9761
Robertson, Andrew, 10211
Robertson, O. H., 9957
Robertson, Russell, 10388
Rogers, Wilmer A., 10246
Ronald, K., 10020
Rose, Curt D., 10168
Ross, H. H., 10257
Rossouw, M. M., 9973
Rothwell, B., 9827
Royer, L. M., 10264
Ruck, Janet E., 9874
Ruggieri, G. D., S. J., 9932
Rychlicki, Zbigniew, 10243
Ryder, R. A., 10255
Ryzhkov, L. P., 9951

Salo, Ernest O., 9728
Sandeman, I. M., 9584
Sandoz, O'Reilly, 9661
Sanford, F. Bruce, 10095
Sangster, A. W., 9815
Sarig, S., 10367
Sato, Ryuhei, 10031
Saunders, Dorothy Chapman, 10350
Saunders, J. W., 9578, 9912
Saunders, Richard L., 9702, 9740, 10005
Saur, J. F. T., 9624
Schaefer, Milner B., 10164
Schaefer, Richard H., 9706, 10013, 10015
Schafer, Harry E., 9651, 9867, 9895
Schafer, William E., 10113
Schäker, W., 10141
Schaumburg, F. D., 10069
Scheffer, Paul M., 10369
Scheier, Arthur, 9975, 10222

Schlicht, Frank G., 9717
Schmickle, Robert D., 10358
Schmidt, Eugene E., 9707
Schmidt, Peter J., 9905
Schmittou, H. R., 9560
Schneider, James C., 10114
Schoettger, Richard A., 9902, 10230
Schoffman, Robert J., 9747
Scholl, Russell L., 10195
Schoumacher, Roger, 9681, 10359
Schwartz, Erich, 9964, 10086
Scott, J. S., 10278
Scott, Thomas M., Jr., 9667
Scott, W. B., 10202
Seckel, Gunter R., 9622, 9623
Seeley, Robert J., 9635
Servis, Robert E., 10192
Shannon, Eugene H., 9881
Sharonov, I. V., 9952
Shcherban', N. P., 9809
Sheldon, Andrew L., 10063
Sheldon, R. W., 10056
Shell, E. W., 9843, 10240
Shell, Wayne, 9643
Shelton, J. M., 10395
Sheri, A. N., 10307
Sheridan, W. L., 10125
Shetter, David S., 9554, 9569, 9683
Shimeno, Sadao, 10039, 10040
Shimizu, Masanao, 10042
Shimizu, Yutaka, 10035
Shirahata, Soichiro, 9834
Shulyak, G. S., 9968
Shumway, Dean L., 9904
Shurben, D. G., 10067, 10110
Shuster, Carl N., Jr., 9818
Siefert, Richard E., 10166
Siegesmund, Kenneth A., 10201
Sigel, M. M., 10154
Sigler, William F., 9695
Sills, Joe B., 9865
Simard, Andre, 10289
Simidu, Wataru, 10035
Simmons, David C., 10399
Simón, Raymond C., 9925, 10177
Sinclair, Sol, 9750
Sindermann, Carl J., 10085
Sinha, V. R. P., 9690, 9691
Skidmore, J. F., 9566
Small, Lawrence F., 10251
Smirnova, G. P., 9969
Smit, H., 9826
Smith, Allen J., 9557, 10347
Smith, Charlie E., 9908
Smith, David G., 10088
Smith, Howard D., 9586, 10391
Smith, J. B., 10311
Smith, J. C., 9780
Smith, Jim R., 9561, 10094
Smith, Lloyd L., Jr., 10008

- Smith, L. S., 9574, 9579
 Smith, Manning A., 9742
 Smith, M. W., 9578, 9912, 10298
 Smith, Stanford H., 9937
 Smith, William B., 9660, 9854, 9882, 10235
 Smitherman, R. Oneal, 9648, 10240, 10244
 Snieszko, S. F., 10019, 10145
 Snow, J. R., 9664, 9863, 10225, 10393
 Somero, G. N., 10376
 Southwick, Charles H., 10296
 Spangler, George R., 10208
 Sparrow, R. A. H., 9933
 Spaulding, Willard M., 10398
 Spencer, Sam L., 9648, 9667, 9892
 Sprague, John B., 9702
 Springer, Stewart, 9625
 Sprules, W. M., 10028
 Squire, James L., Jr., 10092
 St. Amant, James A., 10329
 Stark, G. T. C., 10111
 Starkey, Roland J., 9743
 Starostka, Victor J., 10276
 Steed, David L., 9719
 Steele, K., 9827
 Stephens, K., 10056
 Sterba, G., 9699, 9808
 Steucke, Erwin W., Jr., 10388
 Steven, D. M., 9815
 Stevens, E. Don, 9781, 9800, 9801, 9955
 Stevens, Robert E., 9870
 Stewart, Dorothy D., 9624
 Stewart, G. L., 9592
 Stewart, Kenneth W., 10205
 Stiles, E. W., 9628
 Stockner, John G., 10299
 Strickland, J. D. H., 10250
 Strickland, K. L., 10135
 Stuart, Mary R., 10137
 Stubbs, John M., 9647, 9860
 Studnicka, Maria, 9837
 Sugiyama, Taketoshi, 9970
 Summerfelt, Robert C., 10172
 Sumner, F. H., 10010
 Sund, Paul N., 9612
 Suppes, C., 10383
 Surkova, E. I., 9953
 Suyama, Kazuhei, 10031
 Swallow, W. H., 9989
 Swedberg, Donald, 9634
 Sweers, H. E., 10282
 Swingle, H. S., 9844, 9859, 9878, 10248
 Swingle, Wayne E., 9648, 9667
 Sykes, James E., 9754
 Symons, Philip E. K., 10316
 Szabolcs, M., 9963
 Tabor, Richard L., 9746
 Takase, Yoshiyuki, 10042
 Takayama, S., 10051
 Takemura, Yoshio, 10049, 10050, 10052
 Takeuchi, Masaaki, 10033, 10034
 Tamaoki, Bun-ichi, 9829
 Tamura, Tamotsu, 10038
 Taniuchi, Toru, 10031
 Tarr, H. L. A., 10268
 Tatum, Buford L., 9660, 9882
 Tat'yankin, Yu. V., 9967
 Taylor, Clovis O., 9856
 Taylor, F. H. C., 9924
 Thomas, Allan E., 10395
 Thomas, Bill, 10368
 Thomas, Leon K., 10108
 Thomas, Paul M., 10065, 10199
 Thomas, Shirley, 9815
 Thomas, Sydney F., 9957
 Thompson, Noel, 9957
 Thompson, Richard B., 9563
 Thompson, R. R., 9783
 Thorson, Kenneth N., 9603
 Thurston, Robert V., 9595
 Tibbo, S. N., 10202
 Tiemeier, Otto W., 10104, 10126, 10383
 Tiller, B. A., 9657
 Tocher, C. S., 10272
 Todd, W. R., 9935
 Toetz, Dale W., 9639
 Tomlinson, N., 9576, 9934
 Tomnatik, E. N., 9954
 Toney, Don, 10012
 Topp, Robert W., 9602, 10220
 Torblaa, Richard L., 10396
 Trachtenberg, S., 9750
 Tracy, Harry B., 9993
 Trimborn, F., 9998
 Truscott, B., 9916, 9923
 Tsai, Chu-fa, 10084, 10339
 Tsuchiya, Takao, 10045
 Tsuda, Tsutomu, 10044
 Tsuyuki, H., 10252, 10322
 Tufts, Dennis F., 9563
 Tunzi, M. G., 10059
 Turdakov, A. F., 9823
 Turner, C. E., 10286
 Turner, Jerry L., 9556, 9959
 Ueda, Kazuo, 9831, 10035
 Ulrich, M. Gene, 9632
 Ulrikson, Gerald U., 9987
 Underhill, James C., 9790
 Ursin, Erik, 9733
 U. S. Bureau of Commercial Fisheries, 10097
 U. S. Bureau of Sport Fisheries and Wildlife, 10098

- Van Coillie, Raymond, 9824
Van der Lingen, I., 9820
van Overbeeke, A. P., 9580
Vanstone, W. E., 10217
Van Valin, Charles C., 10186
Varley, Margaret E., 10140
Vasey, Fred W., 9796
Velsen, F. P. J., 9931
Venno, Paul M. W., 10210
Vernick, Sanford H., 10297
Villwock, Wolfgang, 9839
Vladimirov, M. Z., 9954
Vladykov, V. D., 9941
Vogele, Louis E., 9678
Voth, David R., 9636
Vulliet, R. L., 9895
- Wagner, Mary H., 9625
Wainio, A. A., 9737
Walden, C. C., 10069
Waldichuk, M., 10143
Waldron, Kenneth D., 9940
Walford, Lionel, 9729
Walker, R., 10156, 10157
Walters, Vladimir, 9825
Ward, F. J., 10263
Ware, Forrest J., 9875
Warren, Charles E., 9585
Watanabe, Takeshi, 10045
Waters, Thomas F., 10061
Weatherholtz, W. M., 9688
Webb, R. D., 9778
Webb, R. E., 9688
Weber, Douglas D., 9925
Wedemeyer, Gary, 10147
Wegener, William L., 9649, 9855
Weiler, William C., 9996
Weisbart, Melvin, 10116
Weisel, George F., 10351
Weissenberg, Richard, 10155, 10156, 10158
Welker, Bill D., 10356
Welsh, Linda, 10207
Wenger, Alan, 9662
Wenke, Thomas L., 10058
Werner, A. E., 10143
Werner, Robert G., 9559
Westrheim, S. J., 10322
Whealdon, Everett W., 10230
Wheller, Sessions S., 10139
- White, H. C., 10319
White, Ray J., 10091
White, W. R., 9610
White, Warren, 9663
Whitworth, Walter R., 9930
Wiebe, John P., 10122
Wild, Paul W., 9606
Willford, Wayne A., 9614, 9616, 9902
Williams, Austin B., 10107
Williams, I. V., 10127
Williams, James D., 10338
Williams, John E., 9674
Williams, Richard B., 10108
Willoughby, Harvey, 9629, 10232
Willoughby, L. G., 10136
Wilson, K. A., 10020
Wilson, William B., 9718
Windell, John Thomas, 9779
Winslow, Peter C., 10190
Wirth, Thomas L., 10401
Wissing, Thomas E., 10318
Withler, F. C., 9573
Witkovsky, Paul, 9806
Witt, Arthur, Jr., 9564, 9981
Wohlfarth, G., 9758
Wohlschlag, Donald E., 9720
Wolf, Ken, 9918, 10145, 10159
Wolfert, David R., 9997
Wood, Carl E., 9716
Woolcott, William S., 10087
Worlund, D. D., 10283
Wright, Thomas D., 9608
Wydoski, Richard S., 9997
- Yamada, Tomoko, 10032
Yamashita, Hideo, 10037
Yamazaki, Furnio, 10262
Yawn, Henry M., 9864
Yazima, S., 10051
Yerger, Ralph W., 9872, 10341
Yokoyama, Toru, 10032
Yoshimuta, C., 10051
Young, R. W., 9688
Youngson, A., 10375
Yu, Man-Lim, 10192
- Zawisza, J., 10099
Zimmerman, Jerome W., 10093
Zorach, Timothy, 10349
Zubina, N. F., 9962

SUBJECT INDEX FOR VOLUME 13

Age and growth,
 alewife, 9553, 9871
 bass,
 largemouth, 9879, 9897, 10393
 smallmouth, 9666
 striped, 10013
 bloater, 10182
 bluegill, 9897
 bowfin, 10018
 buffalo hybrids, 9869
 Bull Shoals fishes, 9896
 carp, 10353
 catfish,
 blue, 9652
 channel, 9643, 9747, 10195, 10359
 cod, Atlantic, 9739, 9929
 coregonids, 10304
 dolphin, 10168
 eel, European, 9690
 fish in reservoirs, 10355
 goldeye, 10028
 herring, blueback, 9871
 lamprey, sea, 9594
 lance, northern sand, 10278
 marlin, blue, 10180
 metabolic model, 9733
 muskellunge, 10289
 pike, northern, 9769, 10354
 sablefish, 10310
 salmon,
 Atlantic, 9740
 chinook, 10188, 10283
 chum, 10203
 coho, 10317
 pink, 9953, 10286
 sockeye, 10203
 young, 9633
 sauger, 9796
 scale,
 comparison, 10010
 microprojector, 10009
 shad, American, 9871
 shiner, golden, 10014
 spine sections in plexiglas, 9990
 sturgeon, 9822, 10264
 sucker, white, 9594
 sunfishes, Louisiana, 9656
 tarpon, 10016
 trout,
 brook, 9552, 9930
 brown, 9795
 lake, 10256
 marked, 9709
 rainbow, 10012
 walleye, 9796, 10162
 whitefish, lake, 10301
 Anatomy,
 anal fin, sexing brown trout, 9941

Anatomy, cont.
 billfishes gill filaments, 10342
 bluegill, sexing, 9982
 brain esterases, 10265
 carp,
 intestine, 9968
 otolith calcification, 10032
 dace swimbladder, 10261
 flounder, skeleton of young, 10087
 gillraker number, (kokanee), 9921
 lamprey, testis tissue, 9827
 mackerel lateral line, 10381
 mudminnow, central, 9964
 paddlefish pituitary glands, 10344
 perch, shiner, gonadectomy, 10122
 phylogenetic changes, 10129
 retina cells, carp, 9806
 salmonid adipose fin, 10351
 snook osteology, 10346
 toadfish axillary glands, 10297
 trout eye, 10201
 visual pigments, 9788
 walleye eye, 10287
 Behavior,
 barracuda, swimming speed, 9825
 bluegill, 9917
 chemical,
 induced feeding, 9815
 sense organs, 9945
 cod, auditory thresholds, 10209
 feeding,
 ocean fishes, 9943
 rhythms, 9946
 fish schools, 9775
 Gulf of California, 10335
 mackerel, jack, 9919
 migration, 9849
 Ontario lake fishes, 10207
 perch, yellow, schooling, 9938
 pulsed low-frequency sound, 10258
 pumpkinseed, 9763
 salmon,
 Atlantic, 9900, 10316
 chinook juveniles, 10302
 sockeye, sounding response, 10206
 shark, sevengill, 10345
 spawning and care of young, 9847
 sunfish, longear, 9744
 tides and light, 9816
 trout,
 brook, territorial, 10400
 brown, light and activity, 10217
 rainbow, bottom color selection,
 9764
 visibility of objects, 9793
 Benthos,
 Canadian reservoir, 10324

Benthos, cont.

- Colorado stream, 9721
- food availability, 10056
- lake in Michigan, 10114
- Lake Michigan, 10211
- liming farm ponds, 9858
- reservoirs, 9659, 10029
- sampling dredge, 9995
- stream drift and density, 10057
- trout, brown, 10334

Bibliography,

- Abramis brama, 10099
- blood chemistry, 9611
- Canada, 1900-1964, 10291
- furunculosis, 10163
- Israel, 10367
- Oklahoma larval fishes, 9613
- periodicals, world list, 9813
- Progressive Fish-Culturist, 1934-1941, 9692
- salmon, Pacific, 9971

Biocides,

- degradation chlorinated hydrocarbons, 9725

herbicides,

- algicide, CA350, 9723
- Diquat, 10321
- diuron, 9641
- effect on bluegull, 9866
- evaluation, 9864
- fish eggs and fry, 9558
- Karmex, 9865
- manual, 10364
- simazine, 9863

insecticides,

- aldrin, 10380
- Atlantic coast, 9911
- brain cholinesterase, 9936
- chlordane, 10003
- DDT, 10057, 10069, 10089, 10147, 10279, 10312, 10320, 10325, 10401
- dieldrin, 9752, 9966, 10280, 10401
- Dylox, 9663, 10246
- endrin, 9650, 10167
- HCH decay in sea water, 10143
- heptachlor residue in ponds, 9688
- methoxychlor, 9621
- methyl parathion, 9621
- mirex, 10186
- mosquitofish, 9965
- Thanite, 9983

molluscicides,

- amide, 9973
- Bayluscide, 9615

pesticides,

- organophosphates, 10270
- streams, 10100

piscicides,

- antimycin, 9653, 10387

Biocides, cont.

piscicides, cont.

- Bayer 73, 9615
- callicarpone, 9832, 9833
- dimethyl sulfoxide, 9616
- lampreyicides, 9557, 9581, 9742, 9743, 10396
- MS 222, 9902
- phenol, temperature, 9657
- Pro-Noxfish, 9985
- rotenone, 9852, 9874, 9961
- Thanite, 9983
- therapeutic chemicals, 9614
- pollution, 9686
- resistance in fishes, 9728

Chemical factors,

- ammonia, 10070
- copper, 10073
- deoxygenized ground water, 9772
- effect on salmon carcasses, 9765
- feeding behavior, 9815
- Great Lakes tributaries, 10093
- Iowa lakes, 10357
- kraft paper mill effluent, 10069
- manganese cycle, 10101
- oxygen,
 - content, 9701
 - hatchery waters, 10232
 - swimming speeds, 9904
 - under ice, 9978
- phenol,
 - poisoning, 10110
 - salinity, 10067
- phytoplankton blooms, 10248
- plankton, water hardness, 9746
- production fishponds in India, 9722
- reaction to other species, 9945
- registration fishery management chemicals, 9626
- reservoir discharge, 9884
- salinity, 10086, 10139
- strip-mine lakes, 10368
- surface mine waters, Appalachia, 10398
- trout, British Columbia, 9903
- zinc, 9566, 10071, 10072, 10111, 10333, 10385

Competition,

- introductions, New Zealand, 10293
- stocked fish, New Zealand species, 9672
- trout, sculpins, 9585

Culture,

- bass,
 - largemouth, 9663, 9664, 10225, 10229
 - striped, 9660, 9661, 9798, 9870, 9882, 9883
- carp in rice fields, 9949

Culture, cont.

- catfish, channel, 9663, 9992, 10104, 10126, 10241, 10383
- control of,
 - cercariae, 9999
 - leeches, 9837
 - pond weeds, 9863
- diet of warm-water fish, 9843
- East Africa, 9820
- eggs fertilized with mixed sperm, 9823
- fish,
 - for bioassay, 10230
 - loader, 9996
- gyrodactylid control, 9632
- incubators, marine, 9931
- induced spawning, Australia, 9609
- petroleum growth substances, 9948
- pike-perch, 9947, 9954, 9972
- rate of feeding in ponds, 9844
- salmon,
 - Atlantic, 9916, 10219, 10330, 10331
 - chinook, 9988, 10389, 10395
 - chum, 10395
 - in dilute sea water, 9637
 - reconditioned water, 10221
 - spawning beds, 9850
- sole, English, 10370
- trough and pond capacities, 10232
- trout, 10369, 10386
 - amount of feed, 9628, 9629
 - lake, 10388
 - rainbow, 9988, 9998
- wet food dispenser, 10007

Diet,

- bass, largemouth, 10225, 10393
- catfish, channel, 9643, 10126, 10383
- cottonseed meals, aflatoxin, 9703
- esocids, 10226
- esters unsaturated fatty acids, 10033
- fish for bioassay, 10230
- folic acid deficiency, 9908
- perch, yellow, 10392
- rate in culture ponds, 9844
- salmon, chinook, 9619
- starvation, flesh lipids, 10034
- sulfamethazine, 10078
- trout,
 - amount to feed, 9628, 9629
 - lake, 10388
- warm-water fish, 9843

Disease,

- Aeromonas, 9627, 10019, 10266
- aquaria, 9699
- bluegill, 10159
- carp, immunology, 10141, 10142
- chemical control, 10340
- chemotherapeutic, P-7138, 10042

Disease, cont.

- Dermocystidium fungus, 10321
 - digestive tube bacteria, 9836
 - farm ponds, 10242
 - fungus, yellowtail flounder, 9932
 - furunculosis, 10163, 10386
 - hepatoma, 9703
 - infectious pancreatic necrosis, 9918, 10151, 10152, 10153
 - lymphocystis,
 - tumor cells, 10156, 10158
 - virus, 10155, 10159
 - nitrogen gas, rainbow trout, 9834
 - nocardiosis, brook trout, 9922
 - orphan virus, tissue culture, 10154
 - perch, white, 9711
 - Pseudomonas, 10019
 - salmon,
 - Atlantic, 9684, 10137
 - "poisoning", 9704
 - Saprolegnia, English Lakes District, 10136
 - sole, Japanese, tumors, 9970
 - trout,
 - brook, tail rot, 9979
 - rainbow, 10001, 10113, 10135, 10160, 10161
 - viral DNA and cytoplasmic RNA, 10157
 - viral hemorrhagic septicemia, 10145, 10160, 10161
 - whirling disease, 10145
- Distribution,
- bass,
 - kelp, 10373
 - striped, Florida, 9798
 - Britain, fresh-water, 10140
 - bullheads, flat-headed, 10341
 - carp, Canada, 10196
 - catfish, flathead, California, 10329
 - centrarchids, Mississippi Delta, 9888
 - Chesapeake Bay, 9693
 - darter,
 - new species, 10349
 - rock, 10339
 - Delaware River estuary, 9818
 - District of Mackenzie, Canada, 9750
 - Ecuador, freshwater, 9568
 - eel, American, Straits of Florida, 10088
 - kokanee, 9920
 - Long Island surf, 9706
 - Lower Hudson River, 9707
 - mackerel, jack, 10372
 - Minnesota Lake Superior region, 9790
 - Neosho River, Oklahoma, 10074
 - New York stream, 10063
 - North Carolina, 10197
 - Otter Creek, Oklahoma, 10076

Distribution, cont.

- Puerto Rico, 9760
- related to species formation, 9839
- Sacramento-San Joaquin Delta, 9959
- salmon, Atlantic, 10332
- stickleback, ninespine, Indiana, 10337
- sunfish, redbreast, North Carolina, 9881
- triclads, stream-dwelling, 9787
- Trinidad, 9974
- trout,
 - British Columbia, 9903
 - brown, 9794
- Washington streams, abnormal fish, 10343

Drugs,

- acriflavine, 10227
- antioxidants, DPPD and ethoxyquin, 10045
- bass, striped, tranquilizer, 9660
- chemotherapeutic, P-7138, 10042
- Cyzine, 10001
- esters of phosphoric acid, 9837
- Filiksian, 9809
- furazolidone, 10386
- furunculosis, 10163
- guanidine, salmon coloration, 9935
- isobornyl thiocyanacetate, 9983
- malachite green, 10227
- metopirone, 10260
- oxidation, 10148
- paraformaldehyde, Gyrodactylus, 9645
- phenothiazine, 9809
- quinaldine, anaesthesia, 9715
- somatotropic hormone, 10036
- sulfamethazine, 10078
- sulfonamide, 10231
- Tilapia, sex reversal, 9673

Ecology,

- aquarium, fishes, 9699
- cichlid fishes, 10187
- copepod, Lernaea cyprinacea, 10075
- Delaware River estuary, 9818
- emulsified oil, estuaries, 9807
- endangered species, southwest, 10103
- energy flow, Lake Mendota, 10318
- estuaries, 10083, 10107
- Galveston Bay, grass shrimp, 9716
- Great Lakes, 9937
- harvest and lake fertility, 9646
- introductions, New Zealand, 10293
- invertebrate drift,
 - river, 10060
 - stream, 10061
- Lake Huron, sucker-lamprey, 9594
- Mayflies, Mississippi River, 10058, 10169
- Michigan lake, benthos, 10114

Ecology, cont.

- microseston, California, 10059
- reservoir,
 - phytoplankton, 10214
 - populations, 9952
- Sacramento-San Joaquin Delta, 9959
- silversides, Lake Texoma, 10106
- tarpon, Georgia marsh, 10016
- Volga Delta, 9950

Economics,

- carp, Canada, 10196
- catfish ponds, 9873
- District of Mackenzie, Canada, 9750
- Norris Reservoir, 9856
- trout,

farming, 10369

Lake Tahoe, 10112

Electricity,

- boat as electrode, 9647
- capture young salmon, 10224
- electronic marking tag, 9991
- electroreceptors, 9814
- grill, cercariae control, 9999
- heating incubating water, 9998
- shocker, 10363
- telephone generator, 10006
- thinning bluegill populations, 9892

Embryology,

- Chesapeake Bay, 9693
- crappie, white, 10166
- eel, American, 10088
- lamprey,
 - Great Lakes, 10347
 - western brook, 9808
- menhaden, largescale, 10178
- muskellunge, 10144
- Oklahoma, identification, 9613
- pike-perch, 9947, 9972
- rockfish, canary, 9940
- salmon,

Atlantic, 9830

chinook, 9756

sauger, 10184

shad, yellowfin, 10178

sole, English, 10370

surfperch, walleye, 10371

trout, rainbow, 9756

variation in eggs, 9835

walleye, 10184

Equipment,

- bioassay laboratory, 9617
- camera,
 - recording, marine reefs, 10050
 - underwater, 9751
- collector, salmon smolt, 9777
- dispenser, wet-food, 10007
- fence, salmon counting, 10171
- generator, telephone, 10006
- girthmeter, 9997
- grill, electric cercariae control, 9999

Equipment, cont.

- live box, trout, 10390
- loader, hatchery fish, 9996
- marine research, 9753
- marking, 9679
- meter, current, 10109
- microprojector, scale, 10009
- nets,
 - buoyed and anchored, 10210
 - gill, vertical, 10228
 - neuston, 10348
 - nylon trap, 10080
- reconditioner, water, 10221
- sampler,
 - benthos, dredge, 9995
 - bottom, 10011
 - juveniles, 9778
 - plankton, 10276
 - water, 9734, 10008, 10172
- sounder, echo, 10314
- table, operating-anesthetizing, 9574
- tagging device, 9603
- tide timer, aquarium, 9700
- trap, pull-up, shallow-water, 9638
- trawl,
 - electric beam, 10173
 - small boat, 9634
- trotline, crab, 10290
- tube, observing redds, 9994

Estuaries,

- benthos in new ponds, 10295
- chemicals in sediments, 10313
- Delaware River, 9818
- emulsified oil, intertidal life, 9807
- meroplankton, North Carolina, 10107
- Sacramento-San Joaquin Delta, 9959
- tarpon, Georgia marsh, 10016
- Volga Delta, 9950
- zooplankton, Patuxent River, 10083

Farm ponds,

- bass, population estimation, 9648
- catfish,
 - economics, 9873
 - flathead, 9859
- disease, 10242, 10340
- heptachlor residues, 9688
- Illinois, rainbow trout, 9976
- liming, 9858
- parasites, 10242
- phytoplankton blooms, 10248
- shiner, golden, 10014
- stocking combinations, 9630, 9644
- sunfishes, Louisiana, 9656
- trout, 10369
- weed control, 10238, 10239, 10240

Fertilization,

- appraisal, 9840
- rearing ponds, 9842
- shiner, golden, New York ponds, 10014

Fertilization, cont.

- trout lake, 10298

Food habits,

- bullhead, black, 9876
- Bull Shoals Reservoir, 9896
- carp, grass, 9846
- catfish, channel, 9875, 9984
- crappie, black, 9914
- eel, European, 9691
- flounder, starry, 9735
- Great Lakes, 10212
- herring, Cape Fear River, 9871
- logperch, 10176
- Ontario lake, 10207
- pike, northern, 9674
- predators, freshwater, 9946
- salmon, chum, 9933
- sauger, 10287
- seatrout, spotted, 9651
- silverside, brook, 10176
- sole, sand, 9735
- swordfish, 10202
- trout,

- brook, 9721
- brown, 10334
- rainbow, 9618, 10204

tuna,

- skipjack, 9612
- yellowfin, 9612

walleye, 10263, 10287

- zebra danios, Brachydanio rerio, 10128

Genetics,

- bass, striped,
 - x bass, white, 9598, 9882
 - x perch, white, 9882
- buffalo hybrids, 9869
- chromosome preparations, 10205
- chub x shiner, 10252
- darter hybrids, 10138
- lactate hydrogenase, 10377
- menhaden, largescale, 10178
- mosquitofish, female heterogamety, 10132
- resistance to biocides, 9728
- salmon,
 - Atlantic, 10331
 - Atlantic x trout, brown, 10134
 - chum x pink, 10177
 - sockeye, 9741
- sauger, 10184
- shad, yellowfin, 10178
- shiner x chub, 10252
- sucker, white x largescale, 9907
- sunfishes, four crosses, 9944
- trout, rainbow, 10012
- tunas, serum esterase groups, 10131
- walleye, 10184

Habitat improvement,

- brush shelters, 10199
- cover, trout stream, 9676
- reefs, marine, 10043, 10049, 10050, 10052, 10053
- stream,
 - brook trout, 9899
 - Wisconsin trout, 10091

Harvest,

- ages taken, 10218
- anglers, salt water, 10397
- bass, striped, 10327
- bluegill, Michigan lakes, 10165
- cod, Atlantic, 9929
- estimating, 10164
- Florida freshwaters, 9855
- Great Lakes, 9937
- lake fertility, 9646
- Lake Tahoe, 10112
- Louisiana lake, 9868
- mackerel, jack, 10372
- Mobile Delta, 9667
- muskellunge, 10208
- North Carolina, inland waters, 9889
- quarry pond, 9861
- reservoirs,
 - Kentucky, 10105
 - Norris, 9856
 - Oklahoma, 9655
 - rough fish, 9853
- rockfish, blue, California, 10123
- salmon,
 - Atlantic, 10306, 10332
 - Pacific, 9736
 - sockeye, 10249
- spearfishing, Wisconsin, 10115
- statistics, U. S. 1965, 9898
- Tilapia, 9792
- trotline, blue crabs, 10290
- trout,
 - California, 9745
 - Michigan lake, 9683
 - North Carolina streams, 9886
 - rainbow, Lake Taneycomo, 10181
- walleye,
 - Nipigon Bay, 10255
 - Oneida Lake, 9708

Identification,

- billfishes, gill filaments, 10342
- darter,
 - new species, 10349
 - rock, 10339
- disk, electrophoresis, 9783
- flatfishes, Atlantic, 9669
- Kansas fishes, 10047
- kokanee, 9920
- larvae, Oklahoma, 9613
- marine species, 9607
- New Zealand, freshwater, 9696

Identification, cont.

- rockfish, 10322
- salmonids, 9841
- sauger, 10184
- sculpin, new species, 10338
- sharks,
 - new species, 10336
 - Pacific, 9625
- snapper, red, 9838
- snook, osteology, 10346
- species formation by isolation, 9839
- stoneflies, Taeniopteryx, 10257
- trout,
 - brook, 9620, 10253
 - lake, 10253
 - rainbow, 10253
- walleye, 10184
- whitefishes, Great Lakes, 10274

Life history,

- pike, northern, 10030
- rockfish, blue, 10123
- salmon, 10150
 - Pacific, 10116
 - sockeye, 10249
- sauger, 10183
- shad,
 - Alabama, 9872
 - American, 10326
- silverside, brook, 10174
- trout, brown, 9794

Limnology,

- circulation, artificial, 9773
- lake,
 - eutrophic, British Columbia, 9906
 - Ontario, thermocline, 10027
 - temperatures, 10026, 10282
- reservoirs,
 - benthos, 10324
 - Coralville, Iowa, 10358
 - Mayfield, Washington, 10094
 - new and old, 9665
 - Nolin, Kentucky, 10105
 - North Carolina, 9887
 - Round Butte, Oregon, 10081
 - streams, Ozarks, 10365

Management,

- barrier,
 - panels, 10004
 - small spillway, 9986
- bass, striped, 10327
- bluegill, 9892, 10165
- brush shelters, 10199
- carp, 9771, 10196
- chemical registration, 9626
- chlordane, 10003
- cooperative fishery units, 1966, 9761

Management, cont.

estuarine pond, 10295
feeding pond fishes, 9877
fish farming ponds, 9771
fish lock at dam, 9894
fluctuating water levels, 9867
Great Lakes, 9937
harvest, lake fertility, 9646
lakes,
 creel survey, 9890
 strip-mine, 9368
 Tahoe, 10112
 trout, 10298
lamprey, sea, 10396
logging on salmon stream, 10125
North Carolina, 9889, 10197
pike, northern, 9771
pike-perch (*Lucioperca*), 9954
pond filter, 9662
pulsed sound, 10258
quarry pond, 9861
reservoirs,
 Iowa, 10368
 Oklahoma, 9655
 timber, 9862
rough fish control, 9853
salmon, 10150
 Atlantic, 10331, 10332
 coho, Willamette River, 10079
 Great Lakes, 9759
 passage at dams, 9777
sauger, 10183
shad,
 American, 10326
 poisoning, Florida, 9852
spearfishing, 10115
streams, Missouri, 10366
trout,
 brook, 9899, 9912
 brown, 9794
 California, 9745
 Montana streams, 10198
 New Zealand lakes, 10292
 northwest, 10000
 streams, 9654, 9886, 10091
 Wisconsin, 9749
walleye, 10162
water sprayed on ice, 9978
writing, technical article, 10095

Marking,

bass, largemouth, 9649
croaker, Atlantic, 9977
fluorescent pigments, 10308
harpoon adapter, 9910
identifying individuals by divers,
 9678
latex injections, 10170
rapid technique, 10323
related to growth, 9709
salmon, chinook, 9774

Marking, cont.

salmonids, juvenile, 9694
strontium in food, 10254
tags and tagging,
 aluminum, 10391
 device, 9603
 electronic, 9991
 equipment, 9679, 9933
 internal capsule, 9602
 opercular streamer, 10233
 subcutaneous dart, 10309
 versus fin clipping, 9740
salmon, Atlantic, smolt tags, 10005
trout,
 cheek pad injections, 9710
 effect on growth, harvest, survival,
 9554
 trout-perch, 9913
Migration and movement,
barrier panels, 10004
bass,
 largemouth, 9640
 striped, 9556, 10013
bluegill, 9559
downstream, salmonids, 10094
eel, American, 10305
electronic tag, 9991
fish lock at dam, 9894
fishway, Potomac River, 10096
migration behavior, 9849
ocean sound scattering layers, 9924
oxygen and swimming speed, 9904
perch, yellow, 9551
reservoirs,
 fishes, 9776
 Louisiana, 9658
salmon, 10150
 Atlantic, 9702, 10068, 10306
 chinook, 10077
 chum, Japanese river, 10031
 coho, 9770, 10082
 pink, 9732
 scenting spawning waters, 9831
 sockeye, 9593, 9741, 9819
salmonids,
 daily locations, 10259
 turbine intakes, 10179
stream repopulation, 10002
spillway, small-capacity, 9986
sunfishes, Iowa, 10361
trout,
 brook, 9578
 brown, 10068
 cutthroat, 9590
 rainbow, 9561, 10067
tuna, bluegin, 9588

Oceanography,

algae fatty acids, 10272
benthos, coastal food, 10056

Oceanography, cont.

- bottom drift, Canada coast, 9582
- California current, 9592, 9789
- continuous measurements, 9713
- depth and crustacean respiration, 10251
- emulsified oil pollution, 9807
- Hawaii study, 9622, 9623
- hurricanes, beach amphipods, 10294
- oil pollution, 10362
- pesticides, trade winds, 10102
- sound scattering layers, 9924
- starch formation, 10216
- surface currents, Japanese, 10048
- temperatures,
 - Gulf of Mexico, 10303
 - subsurface, 9624
 - warm water discharges, 10092
- water analysis, 10250

Parasites,

- anchor worm, 10246
- bass tapeworm, 10000
- bluegill trematode, 10244
- carp, 9811
- Ceratomyxa shasta, trout and salmon, 10113
- copepods, British Columbia, 9915
- drugs, 9809, 10227
- farm ponds, 10242
- gill, adhesive organs, 10149
- gyrodactylids,
 - chlorine dip, 9632
 - new species, 9705
 - paraformaldehyde, 9645
- Hexamita salmonis, rainbow trout, 10001
- Ichthyophthirius multifiliis, 10243, 10245
- lamprey,
 - Fraser River salmon, 10127
 - Great Lakes, 10020
- leeches, esters of phosphoric acid, 9837
- Lernaea cyprinacea, 10075
- Ligula intestinalis, distribution, 9689
- Louisiana,
 - flatfishes, 9810
 - freshwaters, 9895
- Monogenea, Canadian freshwater, 10022
- Nanophyetus salmincola, 9704
- nematodes, salmon swimbladder, 10021
- North Dakota, 9636
- Oregon coast, 9587
- Proteocephalus fluviatilis, bass, 10120
- Sacramento-San Joaquin Delta, 10379

Parasites, cont.

- salmonids, Newfoundland, 9584
- Salvelinema walkeri, coho salmon, 10024
- shad, threadfin, 9605
- suckers, Alberta, 10023
- Taiwan, 9812
- tapeworm, Texas coast, 9717
- teleosts, new Trypanosoma, 9698
- trout, 9697, 9737
- tuna, skipjack, 10399

Physical factors,

- ciliate colored water, 10277
- light, cataract development, 10388
- pollution, Great Lakes, 10093
- salmon, ocean temperatures, 9766
- temperature,
 - adaptation, 9967
 - carp, 9968
 - catfish, white, 10086
 - control in aquarium, 9989
 - food tolerance, 9969
 - Georgian Bay, 10026
 - Gulf of Mexico, 10303
 - lake, 10282
 - loss salmonid eggs, 9988
 - pike-perch, 9972
 - selection, salmonids, 9570
 - trout, 10068, 10284

Physiology,

- actin from muscle, 10035
- adhesive organs, gill parasites, 10149
- adrenergic receptors, 9781
- amino acid, trout myosin, 9575
- ampullae of Lorenzini, 9814
- bioassay, fish, 10230
- blood,
 - chemistry, 9611
 - eel, American, 10085
 - effect of chlorinity, 10037
 - Red Sea fishes, 10350
 - seasonal characteristics, 9958
- bluegill, 9779, 9917
- bullhead, brown, 9826, 9963
- buoyancy, velocity, 10261
- carp, 9851, 10032, 10045, 10141
- catfish, channel, 9901
- chemical sense organs, 9945
- chitinolytic enzyme, digestive tract, 10046
- cod, Atlantic, 9731, 10200, 10374, 10375
- conversion of food, 9757
- determining fat content, 9758
- dieldrin, liver, 9966
- digestion rate, 9981
- eggs for chromatography, 10192
- endocrine glands, 10129
- enzyme activity, glucose-6-phosphate, 10040

Physiology, cont.

eye retina, 9687
 fatty acids,
 blood and muscle, 10269
 flesh lipids, 10300
 flounder, southern, 10118, 10119
 flyingfish, Atlantic, 9805
 glomerular filtration, urine flow,
 10117
 glycogen, starch degradation, 10268
 hemoglobin, 9962, 10134
 hepatic glucose-6-phosphatase, 10039
 herring, Atlantic, 9923
 iodine in protein, 10273
 metabolism,
 model, 9733
 pinfish, 9720
 sunfish, 10062
 metopirone, 10260
 minnow survival in sodium cyanide,
 9724
 mudminnow, central 9964
 muscle,
 glycogen and phosphorus, 10267
 proteins, 10252
 temperature, 10285
 otolith calcification, 10032
 oxidation of drugs, 10148
 p-nitrobenzoic acid, reduction, 10146
 phenol poisoning, 10110
 pituitary, 10262
 proteins, 10134, 10322
 respiratory quotients, 10275
 salmon,
 Atlantic, 9570, 9802
 blood and heart, 9957
 body temperature, 10352
 changes in maturation, 10281,
 10317
 chinook, 9828, 9925
 coho, 9908
 Pacific, salinity tolerance, 10116
 scent, 9831
 sockeye, 9579, 9580, 9828, 9925
 tissue transaminases, 10215
 salmonids,
 determining cortisol, 9905
 fat storage, 9821
 sarcoplasmic reticular fraction of
 muscle, 9963
 sea water and salts, 10119
 serum esterase, tunas, 10131
 superficial lateral line, 9964
 swimming speeds, 9565
 synchronous hermaphroditism, 10189
 taste fibers, 9803
 temperature and swimming ability,
 10185
 thyroid activity, temperature, 10090

Physiology, cont.

trout,
 brook, 10090
 brown, 9794
 golden, 9600
 rainbow, 9570, 9576, 9595, 9730,
 9738, 9780, 9782, 9797, 9799,
 9800, 9801, 9829, 9902, 9909,
 9934, 9955, 9962, 10110
 semen, fructose, 10191
 Sevan, 9951
 temperature, pyruvate kinases,
 10376
 vision, 9804, 10038, 10130
 water metabolism, 9956
 Plankton,
 California Current, 9592
 chlorophyll derivatives, 9928
 dynamics, arctic lake, 9583
 meroplankton, estuaries, 10107
 phosphate, reservoirs, 9791
 phytoplankton, Ontario reservoir,
 10214
 red tide, *Gymnodinium breve*, 9718
 reservoirs, Missouri River, 10133
 water,
 Alps, 9817
 hardness, 9746
 zooplankton, estuaries, 10083, 10108
 Pollution,
 ammonia, 10070
 Appalachian surface mining, 10398
 bluegill and industrial wastes, 9975,
 10222
 bottom macrofauna, 9727
 chlorinated sewage, 10084
 copper, 10073
 copper-zinc mining, 9702
 detecting copper in fish, 10044
 detergents, 10111
 Great Lakes, tributaries, 10093
 heavy metals and NTA, 10333
 Hudson River, 9707
 kraft pulp mill, 10069
 mayflies, Mississippi River, 10058
 metabolism, 9719, 9720
 oil,
 emulsified, 9807, 10362
 field brines, 10076
 paper mill, shiner, 10065
 perch, white, 9668
 pesticides, 9686, 10100
 phenol, salinity, 10067
 potassium dichromate, 10128
 pulp and paper mill, 9726
 radioactive zinc and phosphorus,
 9762
 Santa Monica Bay, 10328
 residues of heptachlor, 9688

Pollution, cont.

- uranium mill wastes, 9695
- zinc, 10071, 10072, 10111, 10128

Populations,

- bottomfish, California bay, 10328
- catfish, channel, 10359
- ditches, North Carolina, 9854
- effects of fishing, 10164
- endangered species, southwest U. S., 10103
- estimation, acoustical, 10314
- marine research, 9714
- ox-bow lakes, Missouri River, 10356
- ponds, 9844
- salmon, coho, fry in streams, 9942
- sampling, reservoir, 9853
- sardine, Pacific, 10055
- trout,
 - high lakes, 10124
 - Montana stream, 10198
- tuna, yellowfin, 10041
- walleye, 10162, 10384

Predation,

- bass, peacock, 9878
- bowfin, 9564
- catfish, flathead, 9859
- Gulf of California, 10335
- hydra, bluegill, 9987
- otters, Great Lakes region, 9671
- pickerel, chain, 9880
- pike, northern, 9674
- pike-perch, 9954
- reservoir fishes, 9946
- salmon, sockeye, 9563
- trout lake, New Brunswick, 10298

Production,

- bluegill, 9639, 10165
- carp, 9771
- catfish, channel, 9631, 10104, 10241
- cod, Atlantic, 9572
- pike, northern, 9771
- pondfish, India, 9722
- primary,
 - Canadian lakes, 9591, 9596
 - thermal streams, 10299
- reservoirs, Missouri main stem, 10025
- salmon,
 - coho, 9773
 - Pacific, 9736
- trout,
 - brook, 9569, 9899
 - rainbow, 10054

Radiobiology,

- Beaufort Laboratory, 10097
- Ci³⁶, 10089
- cod tissue, 10374
- Cs¹³⁷, 9784, 9845, 10066
- Il²⁵, 10090

Radiobiology, cont.

- Mn⁵⁴, 10017
- radiostrontium, 9786
- Sr⁹⁰, 9785, 10066
- uranium mill wastes, 9695
- zinc,
 - chinook salmon, 9755
 - phosphorus, 9762

- Zn⁶⁵, 10017

Reproduction,

- alewife, 9553
- anchovy, northern, 10380
- Australian fishes, 9609
- bass, striped, 9870, 10382
- behavior, 9847
- bloater, 10182
- carp, 9851
- carpsucker, river, 10360
- crappie, white, 10166
- darter hybrids, 10138
- flounder, winter, 10220
- goldeye, 10028
- guppy, 9752
- lamprey, river, 9827
- marine species, 9931
- marlin, blue, 10180
- mixed sperm for fertilization, 9823
- perch, white, 10307
- pike, northern, 10354
- salmon,
 - Atlantic, 9702, 10319
 - chinook, 9562, 10395
 - chum, 10394
 - dilute sea water, 9637
 - pink, 9573, 10394
 - sockeye, 9573, 9586, 9670, 9741, 9926

sauger, 10183

smelt, American, 10288

tautog, 10193

trout,

- brook, 9569, 9899, 10175, 10279
- brown, 9748, 10292
- lake, 10311
- rainbow, 9677, 9848, 10292
- tuna, skipjack, 10399
- whitefish, lake, 10201

Research,

- bioassay laboratory, 9617
- camera, underwater, 9751
- chromosome preparation, 10205
- cooperative units, 1966 U. S., 9761
- estuarine, Atlantic, 9729
- Hawaii, equipment, 9753
- lake temperatures, 10282
- marine populations, 9714
- natural salmonid hatching, 9994
- ocean measurements, continuous, 9713
- plankton sampler, 10276
- red tide, Florida, 9754

Research, cont.

- reservoirs, Missouri main stem, 10025
- salmonids, reservoir, 10080
- sport fisheries, U.S., 1966, 10098
- 1967, 10315
- surgical techniques, salmonids, 9574
- technical article, 10095
- tissue culture, zebrafish, 9635
- Reservoirs,
 - age and growth, 10355
 - benthos, 10029, 10324
 - bullhead, black, 9876
 - Bull Shoals, Arkansas, 9896
 - chemical factors, 9772, 10357
 - cold water discharge, 9884
 - downstream,
 - effects, Volga Delta, 9950
 - productivity, 10064
 - Fontana, North Carolina, 9887
 - juvenile salmonids, 10080, 10094
 - limnology, new and old, 9655
 - logperch, 10176
 - Louisiana, 9658, 9659
 - management, Oklahoma, 9655
 - manganese cycle, 10101
 - migration behavior, 9776
 - Missouri River,
 - ox-bow populations, 10356
 - plankton, 10133
 - research, 10025
 - Nolin, Kentucky, 10105
 - Norris, Tennessee, economics, 9856
 - phosphate inwash, 9791
 - phytoplankton, Ontario, 10214
 - population formation, 9952
 - rough fish control, 9853
 - Round Butte, Oregon, 10081
 - salmon, coho, 10082
 - sauger, Lewis and Clark Lake, 10183
 - silverside, brook, 10176
 - standing timber, 9862
 - Tilapia, 9792
 - trout, rainbow, 10054, 10358
 - two-story fishery, 9885
 - vegetation control, 9642
 - water fluctuation, 9867

Sampling,

- anaesthetized rock pools, 9715
- bottom, 10011
- dynamite, 9860
- electric shocker, 10363
- herring, Atlantic, larvae, 10210
- gill nets, vertical, 10228
- juvenile populations, 9778
- lamprey, sea, surface net, 10236
- Louisiana lake, 9868
- marlin, blue, sea surface, 10348

Sampling, cont.

- microstrata of water, 10008
- rotenone, efficiency, 9893
- salmonids, Columbia River turbines, 10179
- shocking, boat as electrode, 9647
- surface-midwater trawl, 10234
- telephone generator, 10006
- trap nets, 9680
- trout-perch, 9913
- Specific,
 - Abramis brama, 10099
 - alewife, 9663, 9871
 - anchovy, northern, 10380
 - barracuda, great, 9825
 - bass,
 - kelp, 10373
 - largemouth, 9630, 9640, 9648, 9649, 9663, 9664, 9666, 9879, 9897, 9904, 10225, 10229, 10293, 10393
 - peacock, 9878
 - Roanoke, 10235
 - rock, 9602, 10235
 - smallmouth, 10120, 10185
 - striped, 9556, 9660, 9661, 9798, 9870, 9882, 9883, 10013, 10015, 10327, 10378, 10382
 - white, 9608, 10318
 - bloater, 10182
 - bluegill, 9559, 9560, 9639, 9779, 9877, 9892, 9897, 9917, 9936, 9975, 9982, 9987, 10062, 10072, 10159, 10165, 10186, 10222, 10244, 10270
 - bowfin, 9564, 9981, 10018
 - bream, stone, 10052, 10053
 - bullhead,
 - black, 9876
 - brown, 9826, 9963, 10142
 - flat, 10341
 - carp, 9771, 9806, 9811, 9846, 9851, 9949, 9968, 10032, 10045, 10141, 10142, 10194, 10196, 10243, 10353
 - carpsucker, river, 10360
 - catfish,
 - blue, 9652
 - channel, 9631, 9643, 9663, 9747, 9875, 9891, 9901, 9936, 9984, 9992, 10104, 10126, 10195, 10241, 10245, 10270, 10359, 10383
 - flathead, 9644, 9681, 9859, 10329
 - white, 9599, 10086
 - chubsucker, sharpfin, 10002
 - cod, Atlantic, 9572, 9731, 9739, 9929, 9967, 10200, 10209, 10267, 10300, 10374, 10375
 - crappie,
 - black, 9914
 - white, 9785, 10166

Specific, cont.

croaker, Atlantic, 9977
 dace, longnose, 10261
 danios, zebra, 10128
 darter, rock, 10339
 Dolly Varden, 10189
 dolphin, 10168
 eel,
 American, 9768, 10085, 10088,
 10271, 10305
 European, 9690, 9691
 fish, Antarctic, 10376
 flounder,
 European, 10155
 gulf, 10087
 southern, 9555, 10087, 10117,
 10118, 10119
 starry, 9735
 summer, 10087
 winter, 9555, 10220
 yellowtail, 9932
 flyingfish, Atlantic, 9805
 gar, longnose, 9981
 goldeye, 10028
 goldfish, 9687, 10186, 10275, 10280
 grunt, blueshrike, 10153, 10154
 guppy, 9752
 herring,
 Atlantic, 9923, 10210
 blueback, 9871
 hogchoker, 9555
 lamprey,
 river, 9827
 sea, 9594, 10020, 10236, 10266,
 10396
 western brook, 9808
 lance, northern sand, 10278
 logperch, 10176
 mackerel, jack, 9919, 10372, 10381
 marlin, blue, 10180, 10348
 menhaden, largescale, 10178
 minnow, flathead, 10073, 10385
 mosquitofish, 9965, 10132
 mudminnow, central, 9964
 muskellunge, 10144, 10208, 10289
 paddlefish, 10344
 perch, 9950
 European, 10155
 shiner, 10122
 white, 9668, 9711, 10307
 yellow, 9551, 9938, 10392
 pickerel, chain, 9880
 pike, northern, 9674, 9769, 9771,
 9950, 10030, 10354
 pike-perch, 9947, 9954, 9972
 pollock, 9967
 walleye, 10190
 puffer, northern, 9621
 pumpkinseed, 9763, 10062, 10121

Specific, cont.

rockfish,
 blue, 10123
 canary, 9940
 rudderfish, 10053
 sablefish, 10310
 salmon,
 Atlantic, 9570, 9571, 9682, 9684,
 9685, 9702, 9740, 9802, 9830,
 9900, 9916, 10005, 10068, 10137,
 10171, 10219, 10281, 10306,
 10312, 10316, 10319
 chinook, 9562, 9601, 9619, 9755,
 9756, 9759, 9774, 9828, 9925,
 9980, 9985, 9988, 9993, 10077,
 10078, 10188, 10231, 10259,
 10283, 10302, 10321, 10389,
 10395
 chum, 9606, 9766, 9850, 9933,
 10031, 10203, 10394, 10395
 coho, 9759, 9770, 9773, 9777,
 9904, 9908, 9942, 9985, 10024,
 10079, 10082, 10224, 10231,
 10317
 pink, 9573, 9732, 9766, 9939,
 9953, 10125, 10127, 10286,
 10394
 sockeye, 9563, 9573, 9577, 9579,
 9580, 9586, 9589, 9593, 9597,
 9670, 9741, 9777, 9819, 9829,
 9920, 9921, 9925, 9926, 10127,
 10203, 10206, 10213, 10249,
 10260
 sardine, Pacific, 10055
 sargo, 9604
 sauger, 9796, 10183, 10184, 10287
 seatrout, spotted, 9651
 shad,
 Alabama, 9872
 American, 9627, 9871, 10326
 gizzard, 9852, 10237
 threadfin, 9605, 9627, 9852
 yellowfin, 10178
 shark, sevengill, 10345
 shiner,
 common, 10065
 golden, 9632, 10014, 10167
 silverside,
 brook, 10174, 10176
 Mississippi, 10288
 smelt, American, 10288
 snapper, red, 9838
 sole,
 English, 9726, 9927, 10370
 sand, 9735
 spot, 9650
 stickleback, ninespine, 10337
 sturgeon, lake, 10264
 sucker, white, 9594

Specific, cont.

- sunfish,
 - longear, 9744
 - redbreast, 9877, 9881
 - redear, 10247
- surfperch, walleye, 10371
- swordfish, 10202
- tarpon, 10016
- tautog, 10193
- Tilapia, 9792, 9857
 - melanopleura, 9824
 - mosambica, 9673, 9973
- toadfish, oyster, 10297
- trout,
 - brook, 9552, 9569, 9571, 9578, 9620, 9675, 9721, 9899, 9912, 9922, 9930, 9979, 10090, 10124, 10175, 10223, 10253, 10279, 10298, 10320, 10400
 - brown, 9654, 9748, 9794, 9795, 9885, 9941, 10066, 10068, 10217, 10292, 10334
 - cutthroat, 9585, 9590, 9903, 10139
 - golden, 9600
 - rainbow, 9554, 9561, 9570, 9571, 9576, 9595, 9610, 9618, 9657, 9677, 9703, 9730, 9737, 9738, 9756, 9764, 9780, 9782, 9792, 9799, 9800, 9801, 9829, 9834, 9848, 9885, 9902, 9903, 9909, 9934, 9955, 9962, 9976, 9988, 9998, 10001, 10012, 10033, 10034, 10036, 10051, 10054, 10067, 10110, 10111, 10113, 10135, 10147, 10160, 10161, 10181, 10204, 10253, 10259, 10260, 10269, 10275, 10284, 10292, 10298, 10376
 - Sevan, 9951
- trout-perch, 9913
- tuna,
 - bluefin, 9588
 - skipjack, 9612, 10399
 - yellowfin, 9612, 10041
- walleye, 9708, 9796, 9842, 10162, 10184, 10255, 10263, 10287, 10325, 10384
- whitefish, lake, 10301
- yellowtail, 10046

Stocking,

- air versus hand, 9675
- bass,
 - largemouth, 10293
 - South American, Florida, 9767
 - striped, 9883
- cichlid fishes, 10187
- farm pond combinations, 9630
- fish loader, 9996
- forage fish, New Zealand, 9712
- Great Lakes, 9937

Stocking, cont.

- introductions, New Zealand, 9672
- Lake Tahoe, 10112
- salmon,
 - coho, Columbia River tributaries, 10077
 - Great Lakes, 9759
- strip-mine ponds, 9631
- Tilapia, 9792
- trout,
 - brook, 10223
 - brown, 9885, 10292
 - California, 9745
 - dispersal in stream, 9749
 - lake, 10256
 - Michigan lake, 9683
 - rainbow, 9885, 10292
 - streams, 9654, 9886
 - walleye, 10162
 - Willamette River tributaries, 10079
- Survival,
 - bass,
 - largemouth, 10229
 - smallmouth, 10185
 - striped, 10378
 - chlordan, 10003
 - Fintrol, 10387
 - food and temperature tolerance, 9969
 - menhaden, largescale, 10178
 - minnows in sodium cyanide, 9724
 - muskelunge, 10208
 - salmon,
 - Atlantic, 9740, 9900, 10068, 10306
 - chinook, 9774, 9925, 10395
 - chum, 10395
 - chum x pink, 10177
 - pink, 9939
 - sockeye, 9925, 10213, 10249
 - shad, yellowfin, 10178
 - shiner, golden, 10167
- trout,
 - brook, 9552, 9675, 9683, 10223, 10400
 - brown, 10068
 - cheek pad marked, 9710
 - lake, 10311
 - rainbow, 9618, 9683, 10054
 - walleye, 9708, 10325

Vegetation,

- algae in thermal stream, 10299
- aquarium and marshes, 9699
- control,
 - farm ponds, 10239, 10239, 10240
 - herbicides, manual, 10364
 - reservoirs, 9642
- kelp, giant, 10328
- milfoil in Chesapeake Bay, 10296

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